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1921

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THIRTIETH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXX, PART III, 1921

Gowganda and Other Silver Areas

By A. G. Burrows

I. GOWGANDA SILVER AREA (Fourth Report)

II. AULD AND CANE TOWNSHIPS

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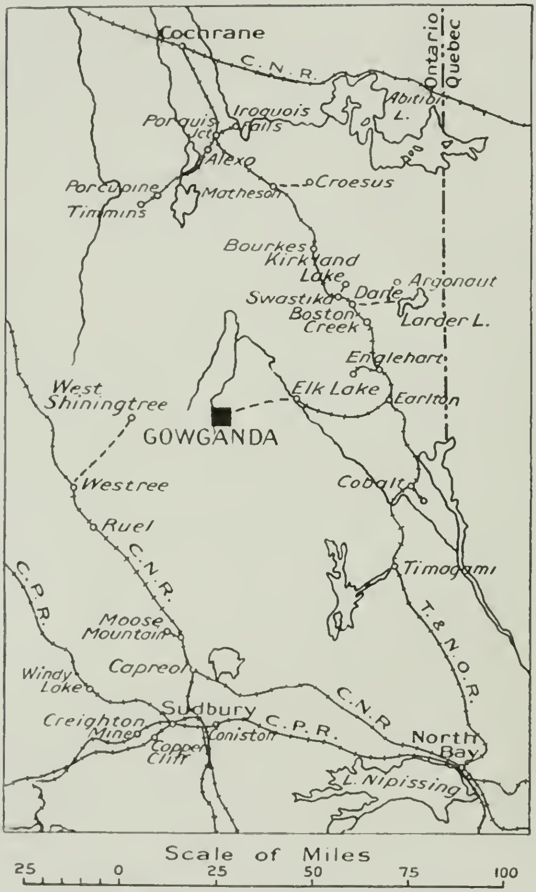

Sketch Map showing location of Gowganda.

I.—GOWGANDA SILVER AREA

(Fourth Report)

By A. G. Burrows

Introduction

The greater part of the field season of 1920 was spent by the writer in revising the geology of the Gowganda Silver area, special attention being given to the occurrence and structure of the Nipissing diabase sill with which the silver deposits are associated.

H. T. Leslie and H. C. Rickaby of Toronto acted as assistants and performed their work well. A number of cross-sections illustrating the position of the diabase sill in its relation to the other formations were prepared from their field work.

The map accompanying the report is a revision of that published in 1910 to accompany the Second Report on the Gowganda Silver Area. It has been enlarged to include portions of the townships of Donovan and Corkill, where discoveries of silver have been made in recent years. Part of the geology in Shillington, Chown, Lawson and Corkill townships has been taken from W. H. Collins' map (1) of the Gowganda area.

Gowganda Lake looking south-west from "Tower" hill.

Location

The Gowganda Silver Area is situated in the south-west part of the District of Timiskaming and forms part of the Timagami Forest Reserve. Gowganda (2) lake, from which the area derives its name, lies about 56 miles north-westerly from Cobalt. The nearest railway station is Elk Lake, the terminus of a branch line running westerly from Earlton, which is on the main line of the Temiskaming and Northern Ontario Railway. From Elk Lake there is a motor road, 27 miles in length, to the village of Gowganda. The easterly part of the road from Wigwam to Elk Lake is in good condition for motor traffic, and it is planned to improve the westerly portion in 1922. A stage operates daily, except Sunday, between Elk Lake and Gowganda.

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(1) Geol. Survey of Canada, issued in 1913.

(2) Gowganda is an Indian name, meaning "porcupine's home."

Topography

The general character of the surface of the country is quite similar to that of other parts of the pre-Cambrian of Northern Ontario. Viewed from hilltops, the surrounding horizon presents a series of gentle undulations with here and there a break, caused by a prominent hill or ridge. In detail, however, the surface is very rough and broken, and different geological formations present differences in surface contour. Rocky ridges alternate with swampy depressions abounding in small lakes over much of the area. The large lakes usually have considerable rocky shore-line, and the water in them is clear. Generally, the longer axes of the lakes are north and south, this being the prevailing direction of the ridges.

The area is situated near the head-waters of the Montreal river, and most of it is drained by the waters of the East Branch of that river, which, together with other streams, flow northward. There is a marked parallelism in the large lakes, which are quite numerous: Spawning, Elkhorn, Gowganda, Obushkong, Bloom, Wigwam, Lost and Calcite lakes. The depressed valleys in which these lakes are found probably originated in extensive north-south fault movements.

The most prominent features are the diabase, conglomerate and greywacké ridges; whereas the granite and syenite of the Laurentian, and the schists of the Keewatin generally occur in low rounded ridges and depressed parts of the area. The highest elevation is attained southwest of Spawning lake, in a greywacké ridge, which is 400 feet above the surrounding level, or about 1,550 feet above the sea. The conglomerate hill to the north east of Obushkong lake is 200 feet above the lake. The diabase ridge at the Gamey-Thompson property in the west part of Van Hise is 200 feet above the plain. Usually the ridges vary from 50 to 150 feet in elevation.

Superficial Deposits

The superficial or unconsolidated material is chiefly sand and gravel and sandy and gravelly loam of glacial origin. The area lies some miles south of the southerly limit of the great clay belt of Northern Ontario. There is no large tract of agricultural land, although in small patches near Gowganda village and at some of the mines fine vegetables are grown.

Jack pine plains and rolling sand ridges are characteristic of most of the south and east parts of the area.

Large parts of Charters, Lawson and Corkill townships are covered with sand deposits which conceal most of the rocks. Some of the low, swampy areas are extensive, as in the northeast part of Leith township.

The timber is chiefly white and black spruce, birch, balsam, jack pine and poplar. Red and white pine are found in small groves in isolated parts. Around Gowganda lake the timber is mostly small, but to the south, in Leith and Charters townships, it is of good commercial size.

Forest fires have destroyed large tracts of timber, particularly in the townships of Haultain, Nicol and Van Hise.

Glaciation

The marks of glaciation, varying from fine striæ to broad grooves or rounded hummocks, are evident at many points. The ice mass moved about due south in this area. Immediately west of Myrtle lake the glacial striæ are S. 10 deg. E. mag., and about 3 miles south on the Crawford claim, H. S. 359, they are S. 20 deg. W. magnetic.

Literature

References to the Gowganda area are to be found in the following reports:

1876.—R. Bell, Report of Progress, G.S.C. 1875-6.
1900.—J. R. L. Parsons, Report of Surveys and Exploration of Northern Ontario, 1900.
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1909.—A. G. Burrows, 18th Report Ont. Bur. Mines, Part II.
1909.—W. H. Collins, Preliminary Report on Gowganda Mining Division, G.S.C. No. 1075.
1910.—W. H. Collins, Economic Geology, Vol. V.
N. L. Bowen, Jour. of Geol. Vol. XVIII.
1912.—G. M. Colvocoresses, Gowganda in 1911, Can. Min. Journ., April 15, 1912.
1913.—W. H. Collins, Geology of Gowganda Mining Division, G.S.C. Memoir 33.
A. G. Burrows, Gowganda Silver Area, Ont. Bur. Mines, Vol. XIX, 1913, Part II, p. 165.
1920.—A. G. Burrows, Gowganda Silver Area, Ont. Dept. of Mines, Vol. XXIX, Part III., 1920.

Production

Shipments have been made from the Gowganda area from the year 1910 up to the present. These have been derived from properties in the vicinity of Miller lake and west of Gowganda lake, together with a few isolated shipments from outlying townships. The great preponderance of ore shipped has come from northwest of Miller lake. Several shipments of high-grade ore have been made from the Mann ridge west of Gowganda lake. From 1910 to 1912 the Millerett mine was the chief producer, the ore coming chiefly from a shoot in the conglomerate which produced 500,000 fine ounces. The Miller Lake O'Brien, which has supplied most of the silver ore yet shipped from Gowganda, has been producing continuously since 1909. The latest property to make shipments is the Castle, ore being obtained not only from the diabase sill but from the Keewatin.

A table is appended giving the production of the mines of Gowganda from the beginning until the end of 1920, the total number of fine ounces of silver being 5,877,592, and of pounds of cobalt "paid for" 134,950.

PRODUCTION FROM GOWGANDA MINES, 1910-1920

Mine	Ore and Concentrates, Tonnage Shipped												Silver,	Cobalt,
	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	Total Tons	ounces	lbs.
Bartlett Crews-McFarlan	*	......				......	......	......	30.20	42.00		72.20	20219	......
Bonsall	3.79	......			......	......		......			13.059	16.849	10046	101
Boyd Gordon	27.00					......	......	......	......		......	27.00	4678	......
Burk-Remey	1.8			......	......		......	......	......	......	......	1.8	......	......
Calcite Lake	......	*			......	......	......	......	......		......	......	......	......
Canadian Gowganda	......	*		......	......	......	......	......	......		......	......	......	......
Castle (Trethewey)	......	......	......	......	......	......	......	......	......		45.31	45.31	48373	......
Miller Lake and Everett	*	......		......		......	......	......	......	......	......	......	......	......
Kell	......				......	......	......	......	......	......	.792	.792	1621	254
Mann			13.74	15.87	18.00	......	......	......	......	......	......	47.61	97792	......
Millerett	347.0	128.0	192.00	......	......	......	......	......	......	......	......	667.00	611822	5000
Miller-Lake O'Brien	31.0	141.5	112.60	166.90	113.90	109.66	170.57	350.00	160.40	189.79	115.087	1661.407	4993457	129595
Powerful	*	......	......	......		......					......	......	......	......
Reeve-Dobie	54.0	......	......	......		......	11.00	5.75	......	1.94	10.44	83.13	88584	......
Welch	1.0	......	......	......	......	......	......	......	......	......	......	1.00	1000	......
Total Ore & Concentrates, tons	465.59	269.5	318.34	182.79	131.90	109.66	181.57	355.75	190.60	233.73	184.688	2624.118	5877592	134950
" Silver .... ounces	471688	468687	549976	502370	399300	242229	383393	1064635	638198	723764	433352	5877592	......	......
" Cobalt (paid for) lbs	8432	......	......	......	......	......	......	56884	26994	27404	15236	134950	......	......

* In addition to the shipments reported to the Department of Mines and shown in the table of production, A. A. Cole's reports for the Temiskaming and Northern Ontario Railway Commission show the following additional shipments:

1909—Bartlett, 2 tons
1910—Everett, 8.35 tons; Powerful, 1 ton:
1911—Calcite Lake, 8.5 tons; Canadian Gowganda, 8 tons

Note.—Shipments of about 6½ tons have been reported in addition from the Hudson Bay properties in Leith township. The silver contents of the Burk-Remey shipment were never reported to the Department.

Table of Formations

The compact rocks of the area are of pre-Cambrian age. The chief geological subdivisions are as follows:

POST-KEWEENAWAN—	Olivine-diabase, quartz-diabase, aplite.
KEWEENAWAN—	Quartz-diabase (sill)
	Intrusive Contact
ANIMIKEAN— (COBALT SERIES)	UPPER: Conglomerate, quartzite, arkose. LOWER: Conglomerate, greywacké, quartzite.
	Unconformity
LAURENTIAN (?)—	Granite, syenite, gneiss.
	Intrusive Contact
KEEWATIN—	Basic and acidic volcanic and intrusive rocks, iron formation, chlorite and hornblende schist, &c.

Note: A number of diabase dikes are older than the Cobalt series and are probably later than the Algoman. They intrude the Laurentian and Keewatin.

Dikes of lamprophyre and dikes and masses of serpentine intrude the Keewatin. They may be of the same age as similar rocks at Cobalt to which W. G. Miller and C. W. Knight have given the name Haileyburian.

General Geology

The rocks at Gowganda are in general similar to those at Cobalt and other parts of Northern Ontario where the pre-Cambrian predominates. The oldest are of Keewatin age, consisting of altered volcanic rocks; greenstones, volcanic fragmental, &c., also iron formation, and with dikes of light-coloured porphyritic rocks. The whole series has been greatly altered to schist, of which hornblende and chlorite schist form a large part. They are in marked contrast, from their ancient metamorphosed appearance and frequent vertical attitude where banded, to the later rocks.

The Keewatin was intruded by batholiths and smaller masses of granite and syenite, that are probably of Laurentian age. Some small masses of serpentine occur in the Keewatin, and numbers of basic dikes older than the Cobalt series intrude the Keewatin and Laurentian. These dikes were intruded long after the granite and syenite and are little disturbed.

This complex of older rocks was subjected to erosion, and on the irregular weathered surface the sediments of the Cobalt series were deposited. This series lies in gentle folds, with average dip of 10 deg. to 15 deg., and has been little disturbed except by the sill-diabase intrusion, when the dip is often higher on the hanging-wall side.

Later than all these rocks is a diabase sill or possibly sills, which occur for the greater part in the sedimentary rocks. Occasionally the diabase has been intruded below the contact of the Cobalt series with the Keewatin, since areas of the oldest rocks lie on the sill in the vicinity of Miller lake. A few basic dikes of olivine diabase and quartz diabase have intruded not only the older rocks but also the diabase sill. These are the youngest recognized rocks in the area.

Quartz-diabase dikes are found in part of the area intruding the Cobalt series, being more common in Leith township than elsewhere. They may also be younger than the sill diabase, but, not being found in contact with the sill, their age cannot be definitely determined other that they are later than the Cobalt series.

Keewatin

The rocks of Keewatin age occur in less volume than the Laurentian, Animikean and Nipissing diabase. They are distributed in isolated areas in several townships, the largest volume of these ancient rocks being in Van Hise, Haultain and Nicol.

The rocks are essentially of volcanic origin, and vesicular and ellipsoidal structures are occasionally seen. They are dominantly of basic composition, and are much altered to hornblendic and chloritic schists. Some of the rocks are massive, but most of them are altered to schist. Intermingled with the basic lavas are some fragmental rocks that resemble old conglomerate, together with some tufaceous or volcanic fragmental material. There are a few belts of banded iron formation, or jaspilyte, now much crumpled. There are also numerous narrow bands of light-coloured rock, like old felsitic or porphyritic dikes, that are folded with the darker volcanic rocks, and which appear to have been intruded at an early time into the volcanic flows. When banded, the Keewatin rocks are in nearly vertical attitude, with a general strike about east and west. Very fissile rocks are common, and also schists that break into flat plate-like structures an inch or more in thickness.

Small masses of serpentine, together with narrow dikes of felsite, porphyry, lamprophyre and diabase, occur frequently in the Keewatin areas.

Types of Keewatin

Hornblende schist and amphibolite occur south of the southwest end of Everett lake. Part of the rock is banded, breaking into plates. A microscopic section shows green fibrous hornblende, the predominating mineral, with grains of zoisite, epidote, secondary feldspar and chlorite.

A greenish weathering massive rock occurs north of Miller lake. A specimen from the south line of claim R.S.C. 87 is scaly fibrous green hornblende, and may be called amphibolite. To the east of Miller lake the rock is more schistose, and is largely hornblende and chlorite schist.

West of Leroy lake the greenstone is much altered, and has a dull green mottled appearance. The rock is rather massive, but passes westward into schist, striking N. 65 deg. E. and dipping 70 deg. N.

To the west of Obushkong lake there is considerable hornblende schist and associated serpentine which is much weathered to a rusty brown color. The serpentine rock also contains some fibrous hornblende and magnetite.

A light-coloured rock is interbanded with greenstone to the west of Obushkong lake. It is fine-grained, consisting of crushed quartz and feldspar with glistening scales of white mica. A dark mineral in thin scales is chlorite, giving the rock a gneissic texture.

Pillow lava occurs half a mile north of Serpentine lake. It is interbanded with a dark-coloured volcanic fragmental rock, one-half mile northeast of Leroy lake. It occurs again on claim W. J. 7, southwest of this lake.

Amygdaloidal lava is associated with iron formation west of Elkhorn lake along the boundary line of Milner and Leith townships. The vesicles of the old lava are filled with quartz, calcite and epidote. Under the microscope the flow structure of the rock is beautifully shown in the parallel arrangement of the minute rods of plagioclase feldspar.

Iron Formation

Banded iron formation occurs in a small area of Keewatin southwest of Elkhorn lake and also one-half mile northeast of Gowganda lake. The formation is quite limited, consisting of interbanded silica and magnetite in thin layers less than 30 feet in width. No iron ore of importance occurs in these localities. The formation is quite crumpled in several separated small bands on claims W. D. 961-964. One silicious band on claim W. D. 963 contains a small deposit of massive iron pyrites.

Dikes in Keewatin

North of Brett lake are several narrow dikes of a reddish brown lamprophyre. The phenocrysts are augite set in a groundmass of feldspar and scales of fibrus hornblende. Calcite in grains and veinlets is also seen.

In the same area there are several dikes of rather fresh-looking diabase. A microscopic examination of one proves it to be a hornblende diabase. The age of many of the diabase dikes cannot be stated definitely, since several that are fresh-looking have proven to be of vastly different age in other parts of the area.

Quartz-Porphyry

There is a large mass of greenish-grey quartz-porphyry directly northeast of Gowganda lake. It forms the main rock of a number of mining claims, many of which show simply the porphyry and narrow north-south dikes of diabase. The porphyry intrudes green schist and iron formation on claims W. D. 961 and is therefore younger than certain of the Keewatin rocks. On the previous geological map of Gowganda it was classed with the Keewatin. It occurs rather as a stock than a dike since its outcrop is nearly round in shape.

No gold has been found in this rock, as in certain quartz-porphyries in some parts of northern Ontario. The formation may possibly be of Laurentian age.

Phenocrysts of quartz are frequently recognized in the porphyry, although there are portions of the mass that are simply a light greenish-grey felsite.

A section of a sample from the south line of claim R. S. C. 123 shows abundant quartz phenocrysts and a few ragged outlines of feldspar. The groundmass is granular quartz and feldspar with a little chlorite.

Laurentian

The rocks at Gowganda classed as Laurentian are granite and syenite, which are in large volume in the townships of Haultain and Van Hise. They are of pink and grey colour, and at times the granite grades into a syenite.

There is a tendency in some parts for the acid rocks to show indications of a gneissic structure, but banding and intense metamorphism, such as occur in the Laurentian in some localities, are not found. There is also the possibility that the granite and syenite may be of later age, say Algoman, but there is no way of deciding this point since no rocks of Timiskaming age occur in the area.

The most common variety is a hornblende granite, generally pink or flesh-coloured. A microscopic examination of a granite from west of Bloom lake shows a hypidiomorphic mixture of quartz, feldspar (orthoclase and acid plagioclase) and green hornblende with a little titanite, apatite and magnetite as accessory minerals. North of Everett lake and extending westerly to Davidson lake, the rock is more syenitic. Dikelets of the syenite intrude the Keewatin west of Everett lake.

Another common type is a grey biotite granite which is intermingled with the hornblende syenite.

There is a small area of porphyritic syenite in Nicol township, just northeast of Wilson lake. Where it approaches the basic Keewatin rocks it becomes darker in colour, with blotches of basic material which have been absorbed from the Keewatin. The porphyritic texture is well marked on the weathered surface where the phenocrysts have been bleached out. Zonal structure is pronounced in the crystals of feldspar, and is due to the regular arrangement of included minerals. The ferromagnesian minerals are green hornblende and a little biotite altering to chlorite; quartz is present in small grains.

Pre-Cobalt Series Dikes

There are numerous dikes of diabase that are at least older than the Cobalt series. They occur in profusion throughout the Keewatin area northeast of Gowganda townsite, east of Miller lake and elsewhere. These dikes have an approximate north and south strike. They are fresh-looking rocks, and except by their association are difficult to distinguish from similar-appearing dikes that occur in the Cobalt series and that occasionally intrude the Nipissing diabase. They generally contain some quartz grains, but on the whole are darker-looking than the quartz diabase of the sill. They show a somewhat rusty surface, whereas the sill diabase usually has a lighter-coloured oxidized appearance. Porphyritic texture is not uncommon in the dikes, with phenocrysts of feldspar varying from half an inch to three inches in length. Such porphyritic texture is not recognized in the diabase sill, and this criterion will serve to distinguish the dikes from the sill where only scattered exposures occur through the drift and relationships cannot be seen. The dikes occurring rarely in the Cobalt series and those that cut the diabase sill strike more nearly east and west than north and south. A number of north and south dikes intruding the syenite-porphyry, which is considered of Algoman age, were observed in the Matachewan area. No acid intrusive rocks that seem to be of Algoman age occur with similar dikes at Gowganda, but the north and south trend and nearness of localities together with the similarity of appearance suggest that the Gowganda dikes are probably also of post-Algoman age. This would place these dikes between the Algoman and Cobalt series in age, and younger than the basic intrusives called Haileyburian in the vicinity of Cobalt.

The dikes have no special characteristics, being of ordinary diabase consisting essentially of plagioclase and pyroxene, with or without interstitial quartz. No olivine was abserved in sections examined. Two porphyritic dikes are very striking in appearance, one on the transmission line, claim H.F. 209, and the other crossing the main road,, on claim T.C. 458, west of Leroy lake. The former of these is older than an adjacent diabase dike with similar north-south strike.

The dikes are not of economic importance as a source of silver since they are much older than the diabase sill. Considerable prospecting was done on them before their age relations were known. Unless in proximity to the sill the possibility of silver-bearing veins being found in them is remote. One of the most interesting localities where the dikes occur is on claims W. D. 961 and W. D. 964. Here they intrude a quartz-porphyry, or felsite, and iron formation, but are overlain unconformably by conglomerate of the Cobalt series. All these formations are intruded by a younger quartz-diabase dike that strikes a few degrees north of east.

Cobalt Series

The Cobalt series covers a great part of the Gowganda area, resting unconformably on the Keewatin-Laurentian complex and being in marked contrast with them. The series has been little disturbed, except where it is in proximity to the intrusive sill of diabase. The strata usually dip at low angles, averaging 15 degrees, for the most part eastward. Near the diabase they are frequently tilted to higher angles, as shown in the outcrop of slate-like greywacké on the easterly side of the high ridge of diabase east of Lost lake. A similar high dip in reddish slaty rock is seen northeast of Lake Irene. In these cases the sediments overlie the sill diabase. No secondary cleavage has been developed, the parting in the slaty varieties following the stratification.

The series includes conglomerate, breccia, greywacké, slate, quartzite and arkose. The lowest formation is usually a basal conglomerate that rests on the Keewatin and Laurentian. Many of the fragments of the conglomerate can be duplicated in rocks that occur in place in the vicinity. The pebbles and boulders include granite, syenite, greenstone, iron formation, diabase, &c.

Greywacké, which in places carries pebbles very sparsely and is occasionally quartzitic, occurs over most of the western parts of Leith, Milner and Van Hise townships. Conglomerate is seen at intervals along the west shore of Gowganda lake, on the south end of the long point on the lake, and frequently also east of the lake.

Freshly banded slate-like greywacké occurs southeast of Myrtle lake on the east side line of claim T. C. 156, and at several other points. It is often brecciated. This is well seen in the localty just mentioned where the slate is in a bluff dipping eastward. The top of the cliff is much brecciated, and overhangs the normal slate below it, which has crumpled away. Similar breccia is seen west of Frying-Pan lake, and on the government road a mile east of Lost lake. These occurrences are near the late diabase, and the brecciation may be due to the diabase intrusion. However, the occurrence near Myrtle lake lies above the contact with the diabase, with layers of undisturbed slate between.

Typical arkose and quartzite occur in great volume in parts of the area, particularly in the southeast portion, including parts of Nicol, Charters and Corkill. The large island on Gowganda lake is composed of quartzite. The arkose and quartzite are generally coarse-grained and thick-bedded, so that the dip is not always readily recognized.

About half a mile north of Wilson lake in Nicol township, the rocks of the Cobalt series dip gently to the west from the Keewatin. The succession is greywacké-conglomerate, slate, quartzite and an upper coarse conglomerate which resembles the conglomerate on the west shore of Gowganda lake. This succession of strata is seen in other parts of the area. Sometimes the greywacké-conglomerate, usually called slate-conglomerate, is underlain by a coarse basal conglomerate which resembles the upper conglomerate.

The latest of the sediments are quartzite and arkose which are sometimes underlain by a reddish slaty-greywacké.

The upper series has a widespread distribution southeast of Gowganda consisting of quartzite arkose and thin beds of quartz-conglomerate which, according to Barlow, have a thickness of 1,100 feet at Maple Mountain. Collins states that the thickness of the lower and upper formations of the series in its present greatly eroded state probably does not exceed 1,000 feet.

"Tower" hill, showing unconformity between conglomerate of the Cobalt series, and Keewatin.

The upper series of quartzite and arkose appears to be barren of economic minerals, but at certain localities it is intruded by sill diabase that carries silver-bearing veins.

Unconformities at base of Cobalt Series

Numerous unconformities between the Cobalt series and older rocks occur in parts of the area, a few of which are herewith described. There is a thin patch of conglomerate, with the underlying granite exposed in places through it, on the northwest shore of Obushkong lake. The conglomerate has rounded and angular fragments of the granite, and also a rusty-weathering diabase which cuts the Laurentian immediately at the contact.

An even more striking conglomerate occurs on claims W. D. 961 and 964 northeast of Gowganda lake. The high conglomerate ridge, on which is located the fire ranging observation tower, rests on a greyish-green quartz-porphyry, iron-formation and diabase dikes of pre-Cobalt series age. Fragments of all these rocks are found in the conglomerate, near its base.

North of Wilson lake, in Nicol township, there are patches of conglomerate on the syenite. The latter rock has a characteristic porphyritic texture, and fragments of it are quite numerous in the conglomerate. The presence of so varied a group of inclusions from rocks occurring in place near the conglomerate indicates that many of the constituents of the conglomerate were local, and not transported any great distance. The old Keewatin-Laurentian surface, on which the Cobalt series was deposited, seems to have resembled greatly in topography that of the present time.

Unconformity in Cobalt Series

In 1909, N. L. Bowen found an unconformity on the north line of H. R. 311, west of Obushkong lake, where greywacké and fine grained arkose show on a bluff about 12 feet in height. At the base of the arkose there are about two feet of a coarse reddish conglomerate containing some small pieces of greywacké which, under the microscope, prove to be the same as the underlying greenish rock, indicating a break in the normal deposition. A similar break was seen southeast of Flanagan lake, near the south line of claim H. S. 712. West of Gowganda lake, and on the long point extending into the lake, an upper conglomerate with a coarse reddish matrix occurs in considerable thickness. Similar conglomerate is seen in other parts of the area. The writer is not certain that the few feet of conglomerate below the arkose series on Obushkong lake is equivalent to all this coarse upper conglomerate. Where a great thickness of conglomerate occurs, a search failed to show any fragments of the underlying greywacké in it or many signs of an uneven and eroded surface.

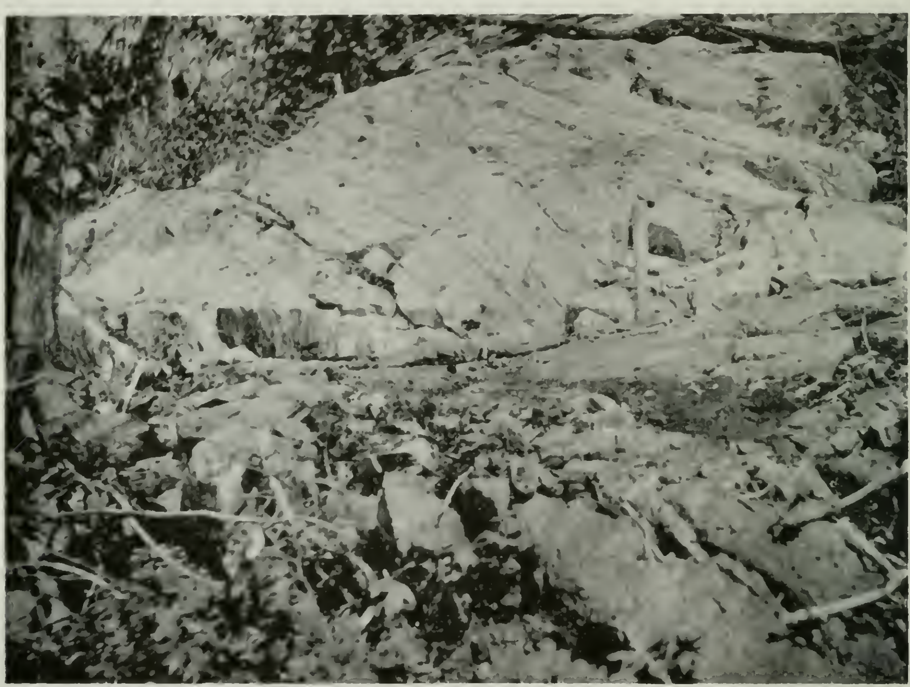
It would appear that there is a local discontinuity in deposition at some points, but the general stratification and dip remain the same in the lower and upper parts of the Cobalt series. Owing to the widespread occurrence of the quartzite and arkose, it is possible to distinguish them from the conglomerate and slaty greywacké by different colours on the map, but the conglomerate, which appears to be part of the upper series, is difficult to separate, consequently it has been grouped with the other sediments apart from the quartzite and arkose. In the earlier reports on the Cobalt area the upper quartzite and arkose were called the Lorrain series. These rocks are similar to those at Gowganda.

Adinole

Where the sill diabase has been intruded into slate-like greywacke, the overlying rock has been sometimes altered by diabase to adinole. The rock occurs abundantly around Lost Lake, being reddish in colour and consisting principally of quartz and crystallized feldspar. Round blackish spots are often developed in the sediments near the contact. A rock of this description is seen along the road a mile west of Lost lake and on claim M.R. 2239 (O'Gorman) in Leith township.

Nipissing Diabase

The most important rock from an economic point of view is the fresh quartz diabase that occurs in the form of laccolithic sills over a great part of the Gowganda area. The resemblance of the outlying areas of diabase to the silver-bearing diabase sill at Cobalt led to the finding and prospecting of all such outcrops over a very wide area stretching from Cobalt to Shining Tree. The Gowganda area is only one part of this wider area in which isolated masses of quartz diabase have been discovered. Consequently, the diabase at Gowganda is similar to that at Cobalt, with the exception that at Gowganda there is a considerable development of the red facies of the diabase, known as granophyre or red rock, in addition to the normal dark-grey diabase. Numerous microscopic descriptions of the Nipissing diabase have been published, including those by C. W. Knight (1), N. L. Bowen (2), and W. H. Collins (3).



Top of diabase sill with overlying banded slate-like greywacké, exposed on claim G. G. 4108, north of Irene Lake.

The rock is generally intermediate to coarse-grained, except at or near contacts where it may be fine-grained and trap-like in texture.

The principal minerals of the normal diabase are plagioclase, usually laboradorite or a feldspar near it in composition, together with augite, affording an ophitic texture. Generally primary quartz, either alone or in microscopic intergrowth with feldspar, is present in the interstices. From the almost constant presence of quartz in micrographic intergrowth with feldspar, C. W. Knight has referred to the rock as a

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[1] Report, Ont. Bur. Mines, Vol. XIX, 1913 Part II, p. 98.
[2] Journal of Geology, Oct.-Nov., 1910.
[3] G. S. C. Memoir, No. 33.

quartz diabase. Small quantities of biotite and magnetite, and occasionally apatite and pyrite, are present. N. L. Bowen has found a subordinate pyroxene, which he believes to be enstatite, in sections from the Gowganda diabase. Ordinarily the diabase is of a dark-grey colour, weathering to a lighter shade, with brownish spots of weathered pyroxene showing on the surface.

This normal type of diabase is observed all across from the foot to the hanging-wall in the sill just west of Miller lake, with no red rock produced as differentiated material. The hanging-wall here is basic Keewatin.

In some places in addition to the grey feldspar there is red feldspar, imparting a mottled character to the diabase. The red is a more acid plagioclase and occurs with quartz in the interstices. This facies can be observed in places along the ridge west of Gowganda lake, e.g. at the Crews-McFarlan and Reeve-Dobie properties, along with the normal dark grey diabase.

Red Rock

A bright red to brown igneous rock occurs frequently with the normal diabase in several parts of the area. It is well exposed to the east and west of Lost lake. It resembles granite, but, owing to its prominent micropegmatitic texture, is called granophyre. Microscopically, it shows crystals of albite surrounded by a radiating intergrowth of quartz and acid plagioclase, together with small quantities of chlorite. The granophyre is so coarse-grained in some localities that the micrographic intergrowth can be recognized in hand specimens. This abundant granophyric rock occurs at the top of the diabase sill in the vicinity of Lost lake, at any rate where remnants of sedimentary rock can still be observed.

The origin of the red rock has been discussed fully by N. L. Bowen and W. H. Collins in the reports previously mentioned. In brief, Bowen believes the red rock, or granophyre, together with adinole, to have been formed by hydrothermal action at the contact on superincumbent slaty rocks. Collins states that most of the red rock has resulted from a differentiation of the diabase magma, with a small portion at the top of the sill being formed by assimilation of overlying greywacké and slate.

Certainly in the vicinity of Lost lake there is strong evidence of contact assimilation and at points it is difficult, if not impossible, to define the boundaries of the intrusive and the sediments.

Structure of Diabase

Miller Lake Area

Since the first examination was made by the author over ten years ago, repeated forest fires have devasted much of the Gowganda area so that parts have been burned off cleanly, affording many opportunities to note the relationship of the various rocks. Numerous contacts of the diabase with older rocks are well exposed in Haultain and Nicol townships. The sill character of the diabase can be determined from exposures showing both the bottom and the top of the intrusion.

Footwall Contacts.—The footwall of the sill outcrops at various points from the wagon road on claim H. J. B. 46, northerly to claim R. S.

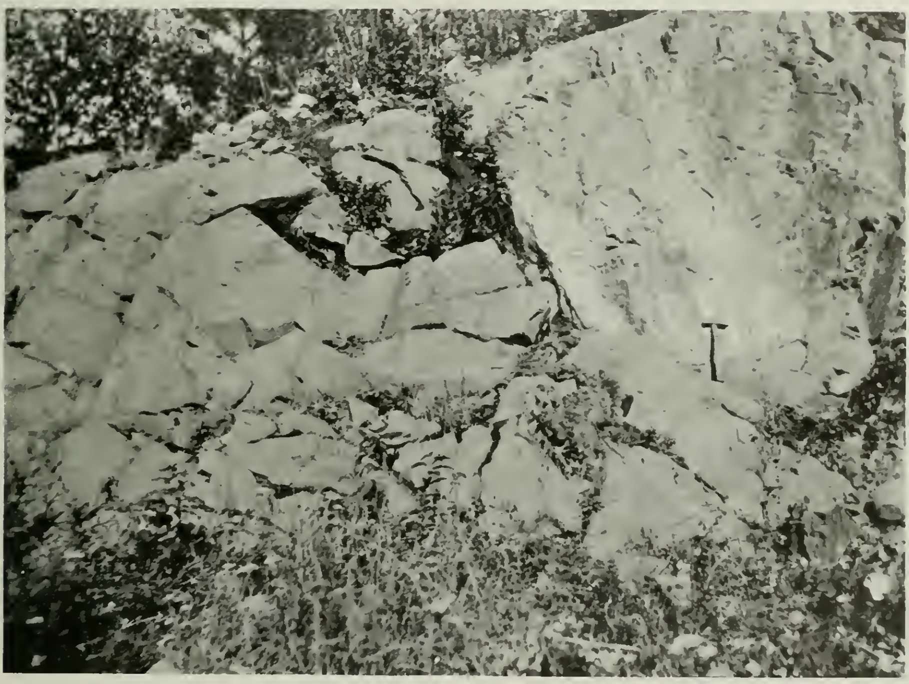
C. 102, near Everett lake, where it swings eastward and northeastward to Shanty lake and beyond. The contact varies from nearly horizontal to 60 deg. Near Shanty lake the diabase overlies the slate-like greywacké almost horizontally, and on claim L. M. 108 it overlies Keewatin banded rocks, dipping 60 deg. N. One of the best footwall contacts occurs on Claim H. J. B. 46 to the south of th road, one and a half miles east of Gowganda lake. The diabase in thin isolated patches overlies the sedimentary rock nearly horizontally in places, with a general undulating dip to the northeast. Judging from the contacts along the footwall edge of the diabase, the sill was intruded very irregularly, only conforming to the dip of the sedimentary strata where they are highly stratified, e.g., the greywacké slate near Shanty lake. The attitude of the sill on claim L. M. 108 has been influenced by the highly banded, nearly vertical character of the Keewatin rocks.

Diabase sill overlying Keewatin N.E. of Castle No. 2, near Everett lake.

Hanging-wall Contacts. —The observed contacts at the upper side of the diabase sill are even more numerous than the bottom. The upper contact is well exposed 100 feet west of No. 2 shaft, Castle mine, R. S. C. 101, on claims R. S. C. 95, 91 and 94 of the Miller Lake O'Brien mine, on R. S. C. 136 (Hart) claim, on claims W. J. 13 and W. J. 6, southwest and south of Leroy lake respectively, and on claim P. B. 140 southeast of Leroy lake.

The circular area of Keewatin rocks, overlain in part by the Cobalt series, occurring in the vicinity of Miller lake, rests on the diabase sill, and it is around this area that most of the contacts just referred to are located. The area of Keewatin and Cobalt series to the east of Leroy lake also lies on the sill, as do the greywacké and conglomerate around Lake Irene. To the east of Lost lake and extending northward to Bloom lake, the diabase sill dips under the sediments of the Cobalt series. For this area the diabase sill has an undulating character, being exposed in places by partial erosion, and at other places concealed by the overlying Keewatin and later sediments. Westward, toward Gowganda lake, the sill has been entirely removed by erosion.

A great number of silver discoveries have been made in the diabase where it is in proximity to the contact with the overlying rocks; that is, in the upper part of the sill around the margin of the Keewatin-Cobalt series area in the vicinity of Miller lake. A few discoveries of silver have also been made in the overlying rocks.



Diabase sill underlying Keewatin, along road south of Leroy lake.

Columnar jointing in the diabase, representing structure at right angles to the cooling surface, is well developed at various places. It is particularly well shown in the cliffs on the Bonsall property, R. S. C. 83, also on claim H. R. 716, S. E. of Leroy lake.

The relationship of the sill diabase to the other rocks is illustrated in a number of cross-sections accompanying this report.

Area West of Gowganda Lake

A sufficient number of contacts have been observed to show that the various outcrops to the west of Gowganda are parts of one sill that has been exposed here and there by erosion of some of the overlying sedimentary rocks. Several ridges of diabase with a north and south strike and with intervening bands of sediment occur from the long point on Gowganda lake westward to Elkhorn and Spawning lakes. The intrusion of the diabase sill was not regular but undulating, principally eastward and westward.

The mass of diabase lying between the north and northwest arms of Gowganda lake dips under the sediment to the east and west. At the north end of this ridge, as shown on claim H. F. 250, the diabase sill rises and the footwall is exposed, showing a thin sheet of diabase on the greywacké. Remnants of the diabase sill occur to the west and north of Diabase lake. The westerly edge of the diabase sill is the hanging-wall side, and the conglomerate along the northwest arm lies on the sill, which is again exposed on the Mann ridge where good contacts of the sediments with the sill can be seen on the LaBrick and Hewitt properties. To the west of the south end of Gowanda lake the Mann diabase ridge divides into two parts. The easterly part dips under the conglomerate to the east, but overlies the quartzite to the west. The westerly ridge also overlies the quartzite, but dips westward under the greywacke that occurs around Long lake. The areas of sediment from Long lake northward to Stuart lake all overlie the sill, which outcrops again near Elkhorn northward to Spawning lake.

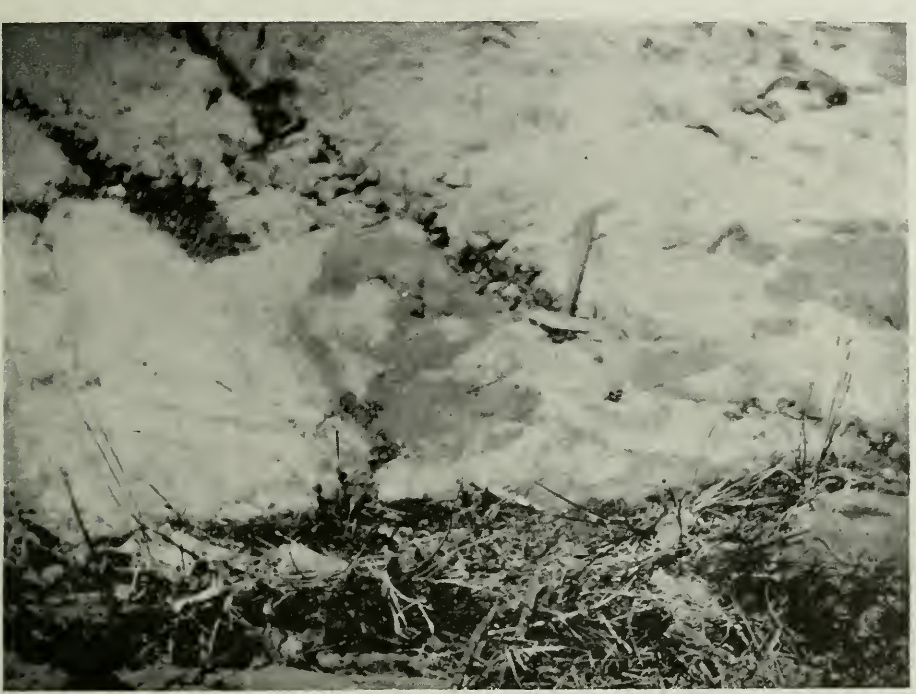
Diabase underlying Keewatin, S. E. of Leroy lake on claim P. B. 140.

No contact was observed along the westerly edge of the diabase with the greywacké near Margueratt lake, but it is believed that this edge is the footwall side of the sill, the conclusion being derived from the attitude of the diabase bluffs facing westward which show columnar structure inclined to the east.

From Elkhorn lake eastward to Frying Pan and Hangingstone lakes only one contact was observed, namely, on claim T. C. 129, and this indicated the diabase to be dipping under the greywacke at an angle of 60 deg. S. E.

The most convenient locality to observe contacts of the sill diabase with the sediments is Gowganda lake. Numerous contacts occur along the east shore of the long point in Gowganda lake showing the sill below the greywacke. The best of these are on claims H. R. 292, and H. S. 377. On the latter claim there is a wide exposure of diabase from which the overlying greywacké has been removed by erosion simply to the contact, exposing the trap-like character of the diabase at the top of the sill.

Good contacts occur also on claim H. S. 451 at the southwest end of the lake, where there is a thin sheet of sediment, a few feet thick, lying on the sill. Some adinole has been developed by contact metamorphism.

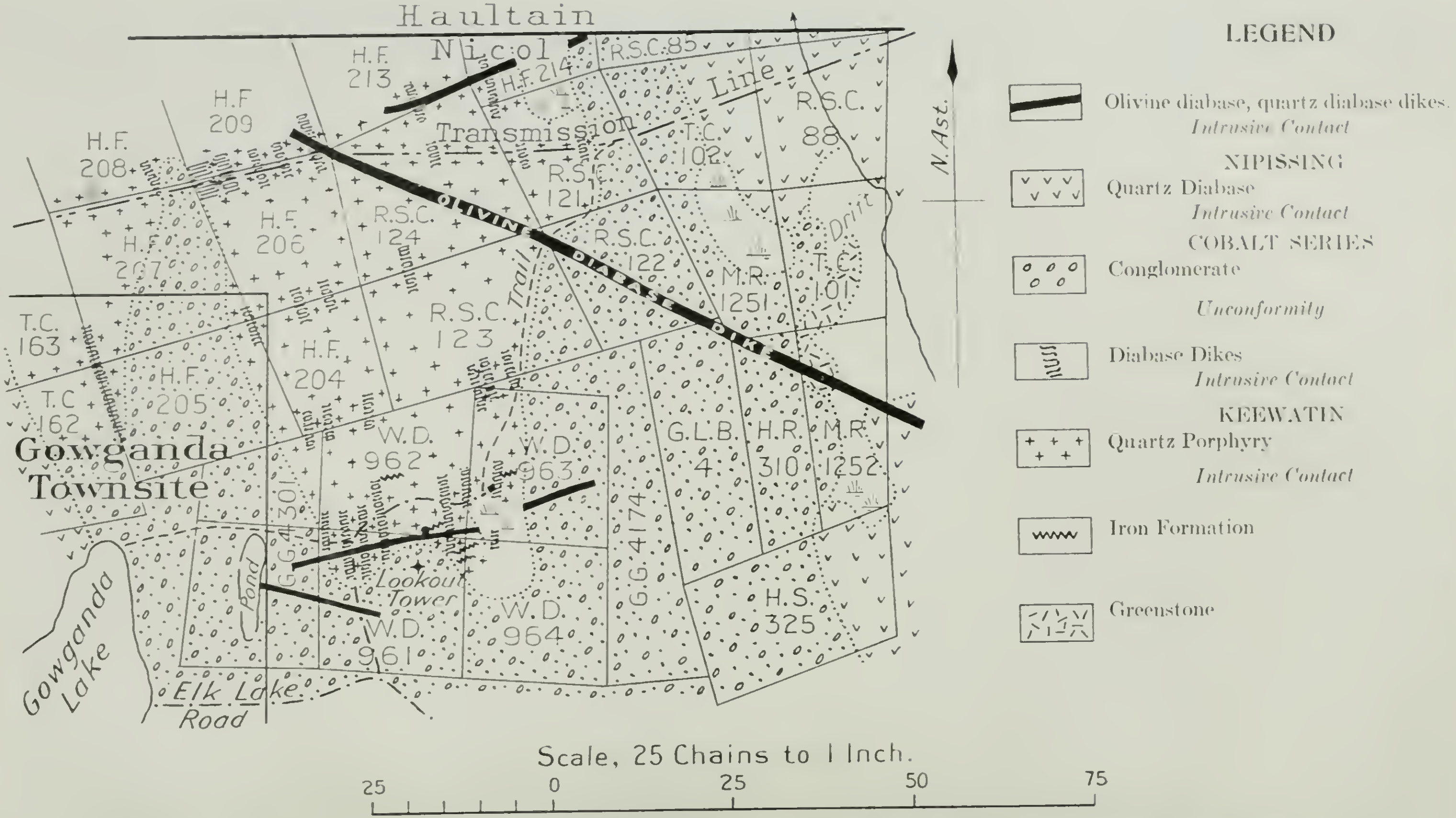


Remnants of diabase sill overlying quartzite on south side main road, 2 miles east of Gowganda.

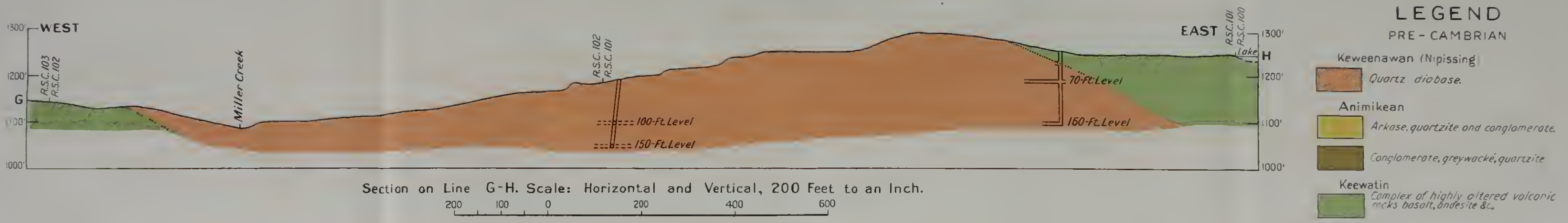
Relations of Nipissing Diabase Areas

An examination of the map of Gowganda will show that the outcrops of sill diabase in the Miller and Lost lake area is separated from the area of sill diabase that lies west of Gowganda lake. Whether these separate areas of diabase are parts of one sill or represent two sills is not known. The topography to the north of Gowganda townsite shows a ravine from Gowganda lake northward to Dinny and Davidson lakes. The same depression can be followed southward by way of the east branch of the Montreal river. The sediments to the east and west of the depression are dissimilar.

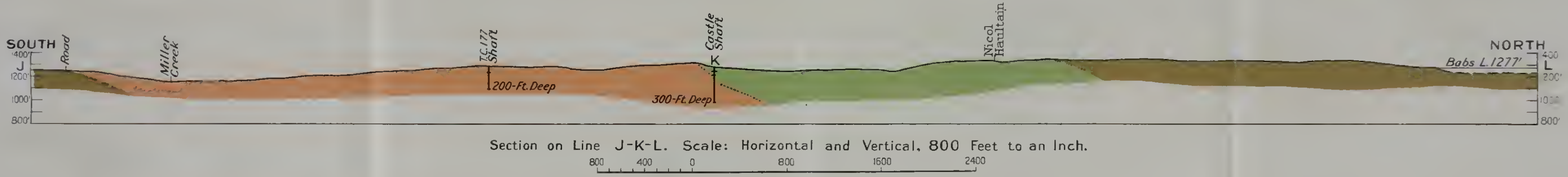
The depression and dissimilarity of rocks could be explained by the possibility of a north-south fault in which the area west of the fault has been dropped. The ravine follows along the easterly edge of a long narrow ridge of diabase. Only one contact was observed along the east side, that being to the west of Davidson lake. The diabase-quartzite contact here is nearly vertical, the inclination, if any, being to the east. Along the west edge several contacts show the diabase overlying the quartzite at an angle of 45 degrees.



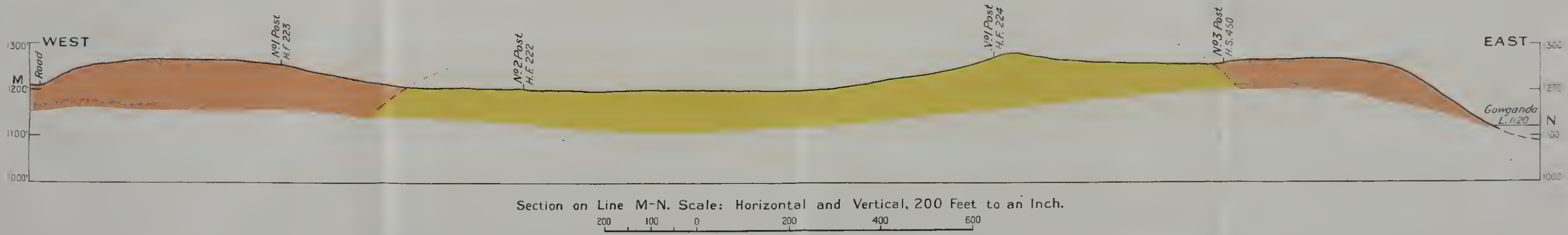
Geological plan of part of Nicol township, illustrating certain diabase dikes older than the Cobalt series, and others later than the Nipissing diabase.



Section on Line G-H. Scale: Horizontal and Vertical, 200 Feet to an Inch.



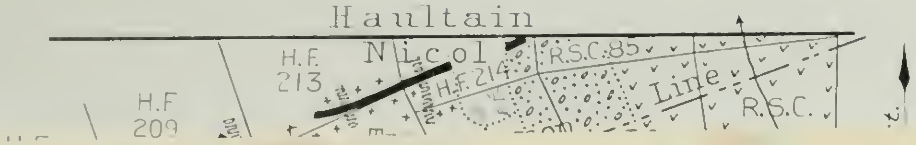
Section on Line J-K-L. Scale: Horizontal and Vertical, 800 Feet to an Inch.



Section on Line M-N. Scale: Horizontal and Vertical, 200 Feet to an Inch.

SECTIONS SHOWING RELATIONSHIP OF NIPISSING DIABASE SILL TO OLDER FORMATIONS AT GOWGANDA

To accompany report by A. G. Burrows in Volume XXX, Ontario Department of Mines Report, 1921.



LEGEND

▬ Olivine diabase, quartz diabase dikes.

Dikes Later Than Nipissing Diabase

Olivine Diabase

Only one olivine-diabase dike was observed in the Miller lake section. This dike is about 100 feet in width and has been traced about five miles in a N.W.-S.E. direction. It intrudes all the other formations, intersecting the diabase sill that occurs around Miller lake. The dike is well exposed along the road on the ridge just west of the Canadian Gowganda property. The rock has a porphyritic texture, showing phenocrysts of light-greenish plagioclase up to an inch in length in an ophitic groundmass of plagioclase, augite and olivine.

A second olivine diabase dike occurs to the northwest of Obushkong lake and is described by N. L. Bowen (1) in an earlier report on the Gowganda Silver Area. This dike may be a faulted portion of that previously described.

Quartz Diabase Dikes

There are also several quartz-diabase dikes, that intrude the Cobalt series, whose relation to the diabase sill is unknown, and several that intrude the diabase sill. These are non-porphyritic, and have a more rusty weathered surface than the sill diabase. Two of these dikes, striking NE-SW, cross the Bonsall property, claims R. S. C. 83 and R. S. C. 84. Their relation to the silver-smaltite-bearing veins is not known. A calcite vein about 3 inches wide carrying masses of galena lies along the contact of one of these dikes with the sill diabase on claim R. S. C. 84. The pure galena carries 11.6 ounces of silver per ton.

Occurrence of Silver Ore

Silver-bearing veins have been found in widely separated areas from Cobalt westward to Shining Tree. Of the outlying areas Gowganda is the most important in discovery of veins and shipment of silver ore. Nearly all the silver deposits are in the Nipissing diabase which occurs in a number of townships around Gowganda lake. The most important townships are Haultain, Nicol and Milner from which a number of shipments of high-grade ore have been made. Silver has also been discovered in several other townships, including Leith, Van Hise, Charters, Lawson, Corkill and Morel. Small quantities of ore have been shipped from Leith, Lawson and Corkill townships.

In addition to those found in the diabase, a few silver-bearing veins have been discovered in the Keewatin greenstone, and the conglomerate of the Cobalt series. Where the discoveries have been made, these formations overlie the diabase sill and the veins are near the hanging-wall contact. In Gowganda no silver-bearing veins have as yet been found in rocks that lie below the diabase sill. At Cobalt most of the ore has been obtained from deposits, chiefly in conglomerate and greywacke, below the sill, which has been removed by erosion.

While a few places in Gowganda reveal the footwall rocks on which the diabase sill rested, most of the sediments and some of the Keewatin rocks are above the sill. The erosion has extended chiefly into the upper part of the sill, exposing it in more or less irregular and connected areas. An example of this is the sill of diabase in the Miller lake section which

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The Cobalt-Nickel-Arsenides and Silver Deposits of Temiskaming, Vol. XIX, 1913, Part II, Ont. Bur. of Mines Report, page 179.

rises toward the west, but eastward to Lost and Wigwam lakes it has several patches of older rocks overlying it. Discoveries of silver ore have indicated the desirability of prospecting the diabase and older rocks in the vicinity of the upper or hanging-wall contact, at least in the Miller lake section.

The workings at the Miller Lake O'Brien mine are all in the upper part of the diabase sill. The rich ore shoot at the Millerett mine, which was mined out several years ago, was in conglomerate that lay above the diabase sill. On the Castle property, R. S. C. 101, a high-grade vein discovered in 1920 was in Keewatin overlying the diabase sill, while operations later proved the vein to continue below the contact into the underlying diabase. Some rich ore was also encountered in Keewatin overlying the sill on the Silver Bullion property northeast of Leroy lake.

The silver-bearing veins at No. 1 shaft of the Castle property, R. S. C. 101, are in the diabase which has been eroded well down from the original top of the sill, and are apparently near the centre of the sill.

The veins at No. 1 shaft, Bonsall mine, are in the lower part of the sill, while those at No. 3 shaft are in the upper part of the sill near the upper contact with the Keewatin.

Silver ore has been found at several horizons in the diabase to the west of Gowganda. At the Boyd-Gordon and Mann properties the veins that produced the ore are in the upper part of the sill; the hanging-wall contact with the greywacké was encountered a few hundred feet west of the Boyd-Gordon shaft.

At Nos. 1 and 3 shafts of the Crews-McFarlan (formerly Bartlett) property, near the south end of Gowganda lake, work was done on several veins that are in the lower part of the diabase sill. The footwall here is quartzite, but the workings have not been carried at either shaft to the contact which can be seen on the surface to the east. The diabase from the bottom workings of No. 1 shaft is fairly fine-grained.

Origin of Silver Ore

Regarding the origin of the silver-cobalt veins at Cobalt, W. G. Miller remarks as follows:—

> The material in these veins has, in all likelihood, been deposited from highly heated and impure waters which circulated through the cracks and fissures of the crust and were probably associated with—followed—the Nipissing diabase eruption. It is rather difficult to predicate the original source of the metals—silver, cobalt, nickel, arsenic and others—now found in these veins. They may have come up from a considerable depth with the waters, or they may have been leached out of what are now the folded and disturbed greenstones and other rocks of the Keewatin. Analyses of various rocks of the area have not given a clue as to the origin of the ores. However, the widespread occurrences of cobalt veins in the diabase, or in close association with it, shown by discoveries during the last seven or eight years, throughout a region three thousand square miles or more in extent, appears to be pretty conclusive proof that the diabase and the ores came from one and the same magma.
>
> The waters are said to be associated or connected with the diabase eruption in the sense that they probably represented the end product of the eruption. In many volcanic regions hot springs are present long after the rocks have been solidified. In the Cobalt area the fissures and joints now occupied by the ores were probably produced by the gradual shrinkage in cooling of the diabase, the ores being deposited by the waters which represented the last stage of vulcanicity. (1)

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(1) The Cobalt-Nickel-Arsenides and Silver Deposits of Temiskaming. Ont., Bur. of Mines, Vol. XIX, 1913, Part II, p. 8.

Veins

Certain characteristics of some veins in Gowganda, Elk Lake and elsewhere seem to point to a genetic relationship with the diabase. A number of the veins are aplitic in composition. The aplite is considered a differentiation from the diabase magma. Frequently the aplite grades into diabase along the walls; at other times it is sharply defined against the diabase walls. Some veins show aplite next to the diabase, followed by a layer of crystallized quartz, the crystals of which extend into the calcite which may occupy the centre of the vein. This type of vein frequently carries some native silver, smaltite and niccolite. The silver in the aplite and diabase is usually in thin scales or sheets. The occurrence of the diabase, aplite and quartz, successively, points to differentiation, while the calcite and the ores have come in later, probably from the same source. The aplite type of vein, however, varies greatly in the arrangement of the constituent parts, the calcite and ores often being irregularly distributed in the aplite.

Most of the veins are not aplite, but the chief gangue is calcite, frequently accompanied by some quartz; in fact, some silver-bearing veins carry considerable quartz. Some of the veins are quite narrow and interrupted, following the columnar jointing planes, and evidently represent the filling of cooling cracks after solidification and skrinkage of the sill.

Many veins are quite strong, and can be traced in a fairly straight course for several hundred feet. They sometimes occur in a series more or less parallel. Several parallel veins with strike N. 15 deg. E. were found on the Mann property west of Gowganda lake. Some of the parallel veins are sufficiently close to mine together. Veins of this character have been worked at the Miller Lake O'Brien and Castle mines.

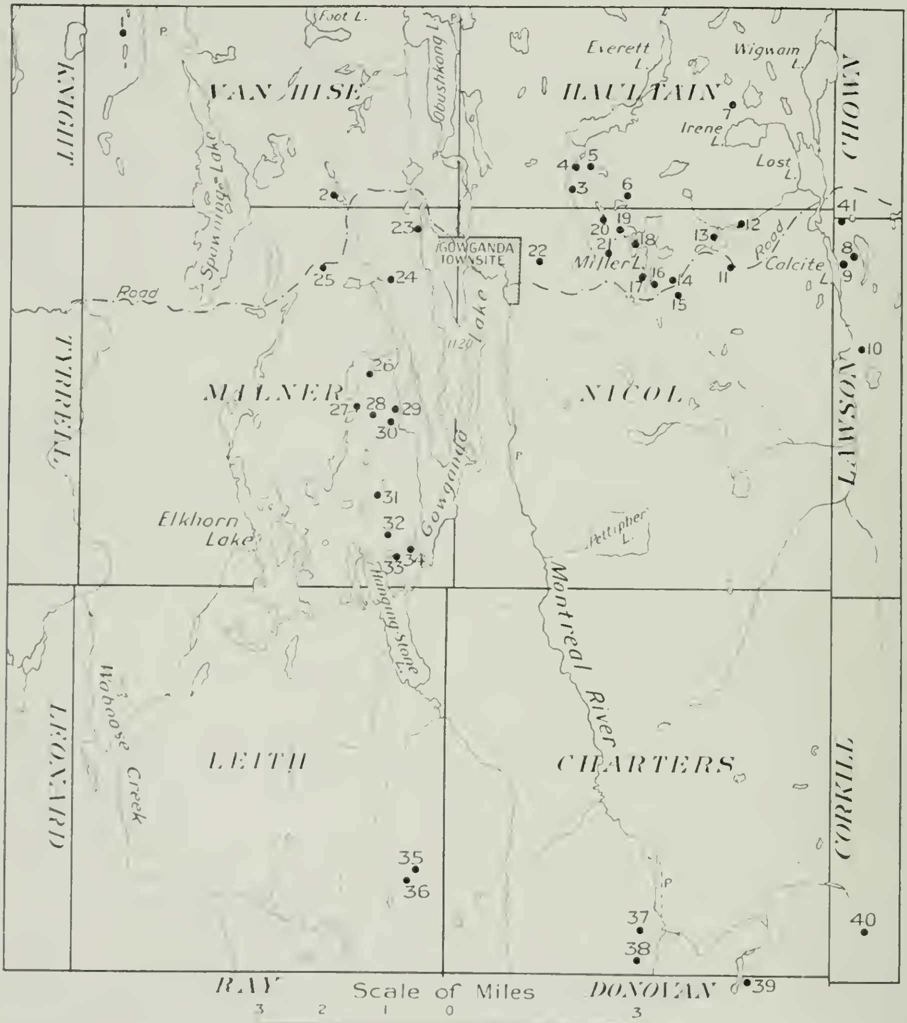
The veins vary greatly in width, and it would be difficult to state an average. The productive veins are usually from a fraction of an inch to 12 inches in width. Veins, however, occur that are as wide as two or three feet, but these are exceptional, and generally the wide calcite veins have not shown much value. One very strong vein, as wide as three feet in place, was found southeast of Miller lake. This vein, known as the Morrison, was traced for 2,000 feet across several claims. On claim T. C. 315 is showed some high-grade ore consisting of silver, smaltite, niccolite and native bismuth, over a length of about 8 feet along the surface.

A wide calcite vein, with east and west strike, occurs on the Miller Lake O'Brien property. This vein cuts a north and south silver-bearing vein.

Vein No. 7 at this property for a portion of its length showed a width of two feet of high-grade ore. The high-grade ore of No. 3 vein, Mann mines, varied from 1 inch to 5½ inches in width.

Several narrow veins with approximately the same strike sometimes unite to form one vein for some distance. Deposits of this character occur on the Miller Lake O'Brien and Castle properties. Where veins are parallel, one vein may carry ore, and an adjacent one may have little or no ore; while farther along in the workings these conditions may be reversed. Where several silver-bearing veins occur over a stoping width, the intervening wall-rock usually carries native silver in the form of thin scales or sheets in minute cracks which are generally roughly parallel with the veins. Even along a single narrow vein, there is generally a little leaf-silver in the rock adjacent to the vein.

A narrow calcite vein an inch or so in width may show segregations over a few feet in length of silver and smaltite entirely filling the vein, while the rest of the vein is calcite with dissemination of copper pyrites.



Map of Gowganda Silver Area, indicating the location of the principal Mines and Prospects

VAN HISE
1 Alpine
2 Hedlund
HAULTAIN
3 Bonsall
4 Everett
5 Castle
6 Symmes-Young
7 Barbara
LAWSON
8 Caleta
9 Bishop
10 Powerful
11 Sanderson
NICOL
11 Lafayette
12 Silver Bullion
13 Collins
14 Northern
15 Canadian Gowganda
16 Johnston
17 Hart
18 Walsh
19 Castle
20 Miller Lake O'Brien
21 T. C.
22 Big Four
MILNER
23 Gowganda Lake
24 Northcliff
25 Bishop
26 Hewitt
27 Boyd-Gordon
28 Mann
29 Milne
30 Silvers Ltd.
31 Reeve-Dobie
32 Crews-McFarlan
33 O'Brien
34 South Bay
LEITH
35 Silverado
36 Hudson
CHARTERS
37 Garvey
38 Haines
DONOVAN
39 Willans
CORKILL
40 Kell

Ore Shoots

As at Cobalt, it has been found at Gowganda that the high-grade silver ore occurs in shoots in the veins. A vein may be several hundred feet in length and show 50 feet, 100 feet or over of an ore shoot, or one only a few feet in length. A number of veins have shown a little native silver in places along them, but with no determinable ore shoots. The ore shoots vary greatly in size. The largest of these so far discovered were in the area northwest of Miller lake. An ore shoot in the conglomerate at the old Millerett property (now Miller Lake O'Brien) was about 150 feet long, averaging about two inches in width of high-grade ore, together with mill rock for about two feet on either side of the high-grade. Some ore shoots in the diabase at the Miller Lake O'Brien mine were several hundred feet in length. Ore shoots 75 to 80 feet in length are worked at the Castle mine. In No. 3 vein, Mann mine, several ore shoots were discovered and developed, varying from 35 ft. to 65 ft. in length. Extremely rich but short ore shoots were mined at the Reeve-Dobie.

These measurements refer to the length of shoots on the surface or in drifts. The pitch length of a shoot may be greater or less than the drift length. Near Miller lake the shoots are generally found to be longer on the pitch than along the drift.

Description of Mines and Prospects

While the geological examination was being made in 1920 there were only a few properties on which mining operations were being carried on. However, since a large number of properties have been worked in various years from 1908, it was thought advisable to give some description, where possible, of the work that had been done in former years.

Haultain and Nicol Townships

Bonsall.—The Bonsall property was among the earliest operated at Gowganda. It includes eight claims: R. S. C 82 to 89 inclusive, situated northwest of Miller lake. The first work was done on claims 82 and 83, on veins carrying native silver discovered by Percy Bonsall in 1908. Most of the silver and smaltite showed in a narrow vein averaging about one inch with strike N. 34 deg. E., which was traced for 100 feet by trenching. The surface of the vein was much oxidized, showing crystallized silver in black, cobalt and nickel, decomposition products. A shaft was sunk on the vein to a depth of 25 feet and a drift run northward.

A main shaft was later sunk on a cross vein that strikes nearly east and west, and varies from about one inch to four inches in width. This vein intersects the previously described vein 30 feet east of the shaft. A drift at the 25-foot level was made along the vein for 60 feet and on the narrower vein for 40 feet. High-grade ore of the character shown near the surface was not encountered. The rich ore was found to occur near the junction of the two veins. About 30 sacks of ore were taken out in 1909. The main shaft was continued to a depth of 125 feet with a north-south drift of 60 feet in a faulted zone on the 75-foot level and 186 feet of drifting and crosscutting on the 120-foot level.

The property was re-opened several years later by the Miller Lake O'Brien interests, who did considerable work at the lower level. A strong north-south fault, dipping 45 deg. E., and showing about 12 feet in width of fractured diabase, was encountered 45 feet east of the shaft. This fault was also crossed at 60 feet in the shaft and would reach the surface in the bed of Miller creek. To the east of the fault the east and west vein was drifted on for 130 feet. The vein carries calcite with some quartz containing copper pyrites, galena and a little native silver. A second vein, 175 feet southeast of this vein, was drifted on for 26 feet. It showed low assay values in silver.

From March to July, 1920, the property was worked under the management of George Glendinning. The workings at the various shafts were de-watered, and the veins sampled at the several levels. At the main shaft, No. I., the work at the 120-foot level consisted in extending the drift on the main vein for 71 feet, and on the south vein for 108 feet with 23 feet of crosscutting. At the 75-foot level a crosscut was made eastward 33 feet to the vein, and 83 feet of drifting was done in a NE-SW direction. A raise was made at the intersection of the vein to the 25-foot level. This level was also connected with the open-cut. From these operations a quantity of silver ore was hand-sorted, bagged and shipped to Cobalt.

In addition to the operations at the main shaft some work has been done on the east side of the property, on claim R. S. C. 84. Two shafts were sunk by the early operators on silver-bearing calcite veins. The east shaft, 60 feet deep with some lateral workings, was found too wet for operating, and a second shaft was sunk to the 100-foot level on a narrow calcite vein, an inch or two in width, that showed a few segregations of silver and smaltite. The drift at the 100-foot level, 74 feet in length, showed the vein to carry a little silver and smaltite, similar to that on the surface. Several veins occur on the surface, but little work has been done. Owing to the favourable location of the veins in the diabase near the upper contact with the Keewatin, it would seem that this locality would warrant more extensive exploration.

The property is equipped with a plant at the western workings, consisting of two 50-h.p. boilers, a straight-line compressor and a hoist. A plant at the eastern workings was destroyed by a forest fire.

Miller Lake O'Brien.—The following is reproduced from the 29th Annual Report of the Ontario Department of Mines, 1920, Part III., pp. 81-84.

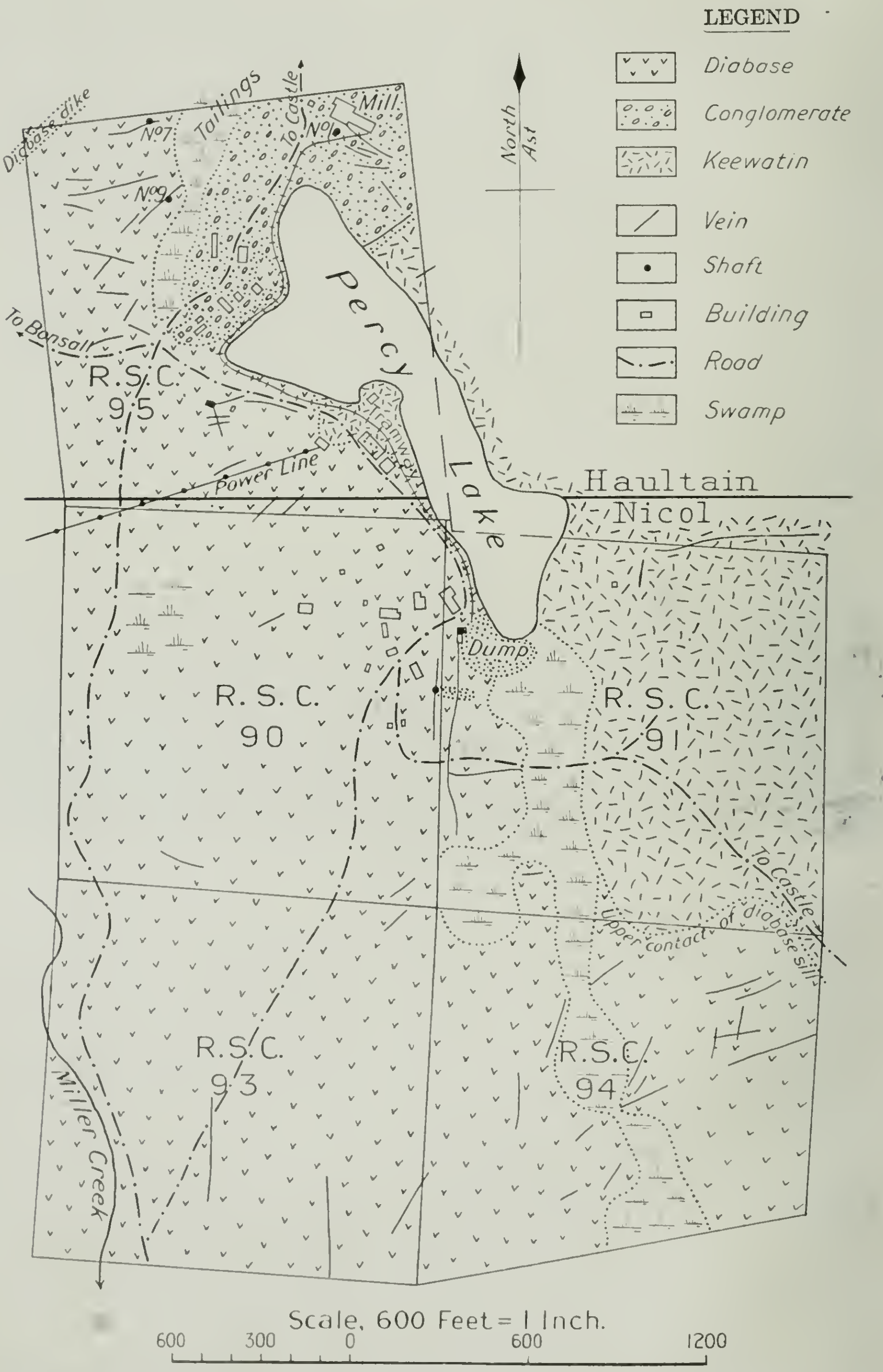
" The Miller Lake O'Brien mine comprises a group of claims to the northwest of Miller lake. They were formerly the Gates claims, on which discoveries of native silver and smaltite were made in 1908. Later the Millerett mine was purchased by the Miller Lake O'Brien Company. The first development was done on veins with a general north and south strike, lying near the line between claims R. S. C 90 (654) and R. S. C. 91 (653). Of these the most important were known as No. 2 vein system, which produced most of the ore in the early years of the mine. Development showed the veins of this system to dip steeply to the west, with the pitch of the ore-shoots to the south. Of this system, the footwall veins have been the most productive. The ore-shoot in the hanging-wall veins did not extend to the 140-foot level, whereas the footwall ore body continued nearly to the 350-foot level. Each of these series carried two or more veins, which were sufficiently close together, where the ore-shoots occurred, to allow mining in one stope. The veins were generally from two to five inches wide, and in the ore-shoots individual veins were not always productive, but where one was barren, a parallel vein would carry high-grade ore. Very little ore was taken from this system above the

60-foot level. The greater proportion of the silver values was confined to the veins themselves, there being only a small impregnation of the wall rock. Strong east and west faults dipping 30 deg. north were encountered in the workings on No. 2 system. In developing this vein system a series of cross-veins was encountered south of the shaft, on the 250-foot level, having an east and west strike. This series of veins is known as the cross-system, and dips to the south at a high angle. An ore-shoot was found on the 250-foot level, and was stoped a short distance above the 140-foot level. It was followed down below the 400-foot level with decreasing length along the drifts.

" The latest discovered ore system is known as the ' Flynn.' The first ore was encountered on the 350-foot level. A long east and west drift had crossed a very pronounced north and south fault, (c) dipping 50 deg. east, and a northerly cross-cut had intersected No. 6 vein, which was followed by a second fault, striking east and west and dipping 30 to 40 deg. to the north. Ore was found in No. 6 vein above this fault. From this discovery the development was extended to a number of veins, the principal of which are No. 6, No. 7 N., No. 7 N.W., etc. On stoping No. 6 above the 350-foot level it was found to join No. 7 N., producing the greatest width of high-grade ore found in the mine, where one portion of the vein was three feet wide, of high-grade silver, smaltite and calcite. Later, in drifting on No. 7 vein on the 350-foot level, portions of it were of high-grade ore two feet wide. In this rich section of the ' Flynn ' system, the stope was 14 feet in width, in places of high-grade veins and mill rock. Development in this part of the mine threw light on the ore relationships. The workings show that the high-grade values did not extend into the Keewatin, while in that formation the veins themselves became more indefinite, branching into stringers carrying galena, copper pyrites and other common minerals. The contact as determined at a few points in different parts of the mine dips from 20 deg. to 30 deg. (with the sill diabase below the Keewatin greenstone) gradually flattening.

Miller Lake O'Brien mine.

" Development has proven the aforementioned east and west fault to be generally the lower boundary of the ore. The veins carrying the ore are said to have been only slightly displaced by the fault. One vein, No. 7 N.W., was absorved to have been faulted about three feet. In this vein the east and west fault is not the lower boundary of the ore, since ore was being stoped from it on the 400-foot level below the fault. The ore occurs



Surface plan of Miller Lake O'Brien mine. Claim R.S.C. 95 was formerly the Millerett mine.

in the diabase below the Keewatin greenstone, while the main ore-shoots pitch to the north, being controlled by the Keewatin-diabase contact and the east and west fault, the ore not necessarily coming close to the contact. In developing vein No. 7 N., which carries the principal ore body, an inclined winze (87 deg. W.) has been carried from the 350-foot level to the 525-foot level, and the ore from this and other veins is developed from the several levels.

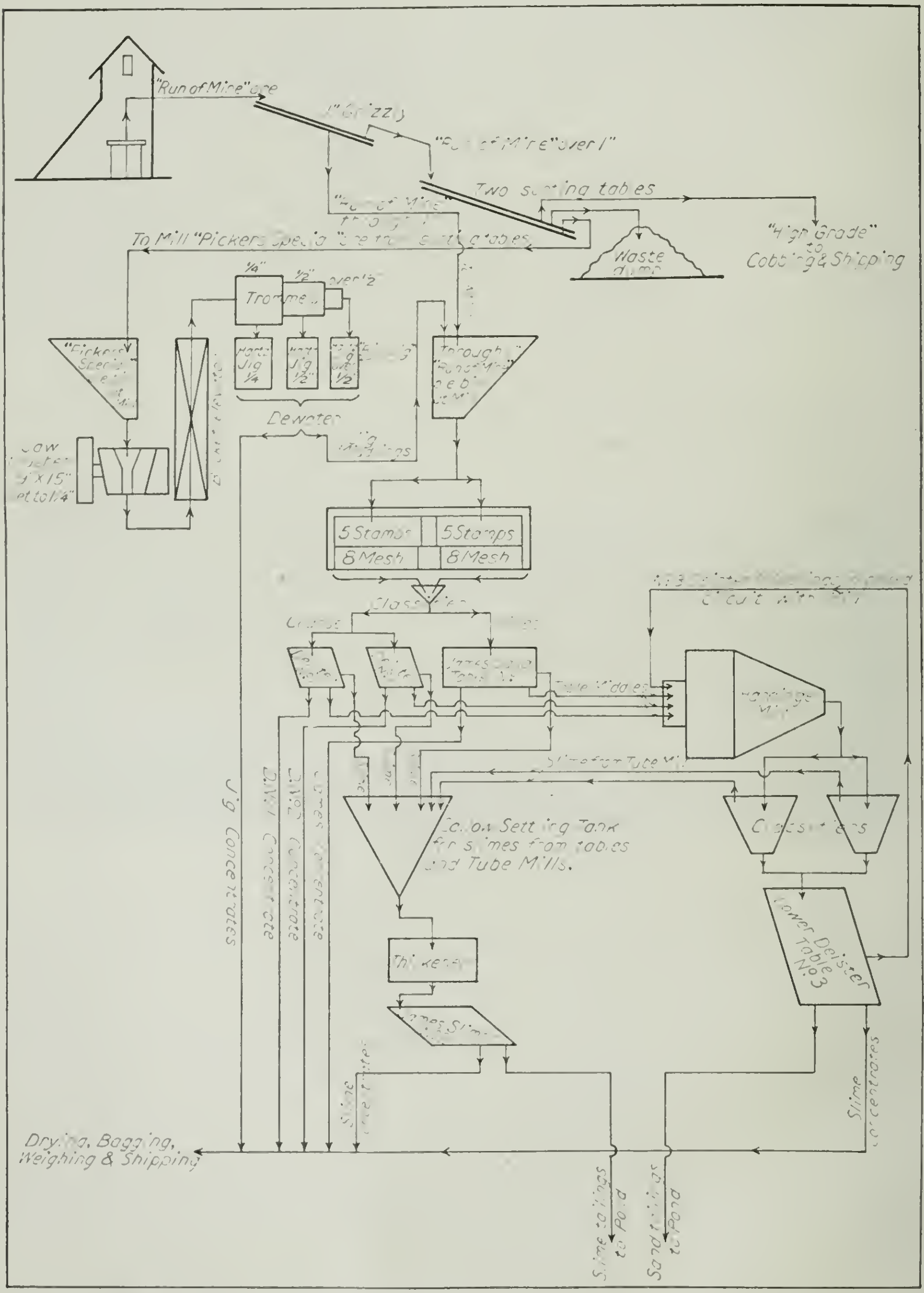
" Development at this mine on R. S. C. 90 and 91 has shown all the ore so far to be in the diabase. The early workings at No. 2 vein system were in the diabase, which outcropped at the surface, where only a small portion of the sill had been eroded. Later work being in the diabase below the Keewatin, it has been determined that silver ore occurs at greater depth from the present surface, depending roughly on the Keewatin-diabase contact. The silver ore occurs in the upper portion of the diabase sill in proximity to the contact.

Part of Miller O'Brien mine, showing mill.

" The treatment of the ore is shown by the flow sheet diagram, page 28. The ore, after passing through the high-grade and water-sorting treatment at the main shaft, is hauled in trains of 2-ton cars to the incline at the mill by a gasoline motor. The cars are drawn up the incline singly by a hoist to the mill ore bin. About 35 tons of ore are treated daily in the mill. The mill was operated originally by the Millerett Mining Company, and is situated about a quarter of a mile north of the main shaft.

" Power for the mine and mill is supplied by a hydro-electric development at the foot of Gowganda lake. The natural fall is 27 feet, but by a dam is raised to 30 feet and the installation is capable of developing 500 horse power. The transmission line is 2¼ miles in length and the voltage 4,000. About 300 horse power is required for the mine and mill; in dry seasons, owing to the lack of storage, this requirement is not always met."

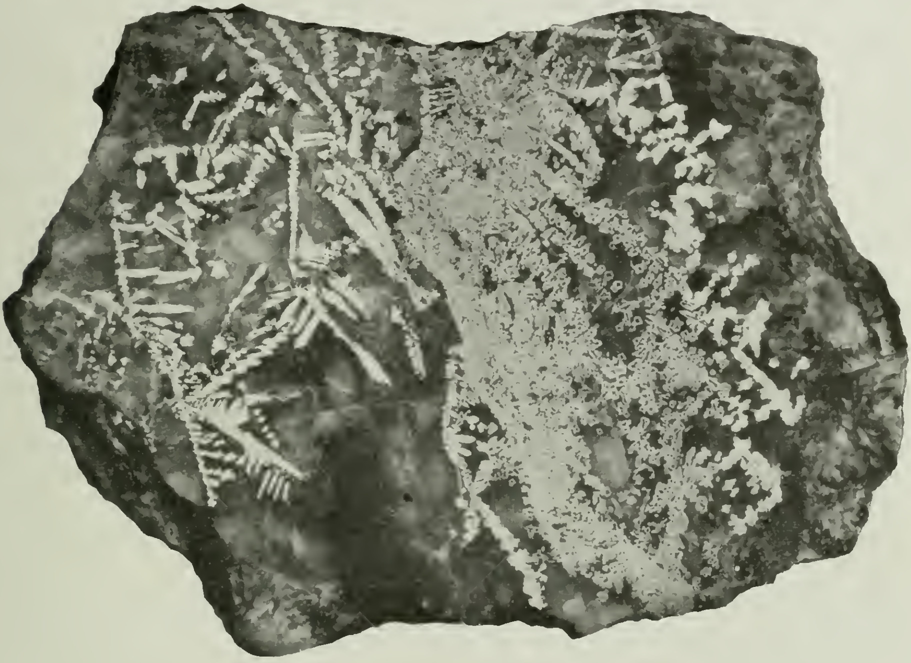
During 1920 operations were continued on the series of veins in the Flynn system. A new vein, No. 16, carrying native silver, which lies 25 feet west of the north part of the main vein, No. 7 N., was discovered and drifted on for 140 feet on the 460-foot level. This vein lies above the



Floor Sheet, Miller Lake O'Brien mine.

strong north-south fault C. which dips 50 deg. E., and the ore-shoot in this vein, as well as N. 7 N.W., was not located below the fault. Further work was done on vein No. 7 N.E., in which ore was found on the 525-foot level below the prominent east-west fault, called the ore fault, which in several veins terminated the downward extensions of ore shoots.

J. G. Dickenson of Cobalt is general manager, and H. G. Kennedy is resident superintendent.



Specimen of polished ore from Miller Lake O'Brien mine, showing fern-like structure of crystallized native silver and smaltite (white) and crystallized smaltite (light grey) in calcite gangue (dark grey.) Some of the silver occurs in minute veinlets in the calcite and smaltite.

Symmes-Young.—This property, H. S. 351, is located about a quarter of a mile north of Miller lake. The outcrops show conglomerate and greywacké of the Cobalt series overlying Keewatin greenstone. These formations overlie the diabase sill that outcrops nearly one-half a mile to the west, and has a gentle dip to the east. Two hundred feet west of No. 1 post there is a strong smaltite-niccolite vein that strikes approximately north and south. It crosses the line to claim H. S. 350, being traceable on both properties for about 700 feet, and is in the conglomerate-greywacké. A shallow shaft about 44 feet in depth has been sunk on claim H. S. 350, fifteen feet north of the line. The vein had a maximum width of a foot when the shaft was located, but diminished rapidly to the north and south and also in the shaft. In places there are several narrow veins running from an inch to three inches in width. At 30 feet in the shaft there are several veins in a width of 15 inches. The walls of the shaft are stained with pink and green arsenates. At the bottom of the shaft the rock is greywacke, the Keewatin not having been penetrated. The ore is smaltite-chloanthite and niccolite intimately intermixed. It carries less than one ounce of silver per ton. A sample of the grey smaltite-chloanthite examined by J. A. Reid contained 12.44 per cent. of cobalt and 13.31 per cent. of nickel. The depth of the diabase sill below the Keewatin and Cobalt series is not known, but the vein contents in all probability have been derived from the diabase sill magma.

Haultain Township

Castle (R. S. C. 101)—Claim R. S. C. 101, which is one of a number of claims of the Castle group situated about half a mile south of the west end of Everett lake, has been operated continuously by the Trethewey Silver-Cobalt Mine, Limited, since the fall of 1919, when trenching near the west line of the claim revealed some narrow veins carrying high-grade silver ore. The veins are continuations of fractures that were worked several years previously on claim R. S. C. 102 by the Miller Lake and Everett Mines, Limited. They strike approximately N. 30 deg. W. and dip 85 deg. SSW. As shown near the surface, the ore deposit consisted of a series of closely spaced calcite and quartz veins over a width of 18 inches. In sinking the shaft the veins were found at times to unite into fewer and wider veins, a width of 5 inches of high-grade ore being occasionally encountered. The high-grade ore averaged about three inches in width. The chief vein-filling is calcite, but quartz is abundant. Native silver, smaltite, copper pyrites and specularite occur in parts of the veins. Where there are several narrow veins, one may carry ore and an adjacent one be practically barren at the same horizon; while the values may shift from one vein to another on further working. The diabase adjacent to the veins frequently carries leaf silver, sometimes in short heavy sheets. The ore shoot has been developed by means of a shaft to the 150-foot level. At the 100-foot level the shoot is about 80 feet in length, the shaft being located near the centre of the shoot, which pitches nearly vertically. Two stopes, 25 feet in length, were opened 10 feet from the shaft on the 100-foot level, and carried toward the surface. A third stope was opened southeast of the shaft at the 150-foot level. The broken ore and rock from the stopes is passed over picking tables, and the ore sorted from the waste and mill rock. With the high-grade from the veins and the higher-grade wall rock a product is obtained averaging approximately 1,000 ounces to the ton. The mill rock is accumulated on the dump for possible future treatment.

Exploratory work was also carried on at the 100-foot level, a series of veins having been drifted on for 350 feet southeast of the shaft. A northwesterly cross-cut intersected a wide calcite vein, but no exploratory work was done on this vein. Several strong veins outcrop on the southwest part of the claim, but underground work on the 100-foot level was not carried to their probable underground extension.

The ore shoot just described is probably located toward the centre of the sill, as indicated in the accompanying cross-section, in which respect it differs from the more recently discovered ore shoot on the east part of the property. This ore shoot occurs in Keewatin greenstone at and near the surface, and has been proven by exploration to pass into the underlying diabase sill, the contact of which with the Keewatin is exposed at the surface about 100 feet west of No. 2 shaft. This high-grade vein was discovered by Tom Garvey, a prospector, in the spring of 1920. The vein strikes nearly east and west magnetic, and dips 80 degs. to 85 degs. N. An open cut about 30 feet long was first made along the ore shoot from which some high-grade ore was extracted. Oxidation extended downward several feet and loose fragments of native silver up to 15 inches in length were taken from the black decomposed cobalt oxide. The fresh ore is smaltite and native silver in calcite. The bottom of the open cut showed in places a width of three inches of high-grade ore. Several sacks of silver in loose pieces were shipped from the open cut.

To develop the ore shoot a vertical shaft has been sunk at its eastern end, the vein being intersected at several levels by cross-cutting. The contact between the Keewatin and the Nipissing diabase was encountered at a depth of between 25 and 30 feet. As the Keewatin rock is a fine-grained diabase, or basalt, the exact location of the contact is difficult to determine without microscopic examination of the rock. The Keewatin rock contains much hornblende and may be called a hornblende diabase.

As already stated, the high-grade ore shoot was found to continue from the Keewatin into the sill diabase, shown in the sub-drift at the 30-foot level. After entering the diabase, the vein was succeeded by a second overlapping vein 15 inches to the north, in which the high-grade ore continued downward. In the drift the vein shows in places two inches of high-grade ore with some leaf silver in the wall rock. The vein was also cut at the 70-foot level where the ore shoot was encountered a few feet north and west of the shaft. The drift at this level is reported to follow the ore shoot for 75 feet. When first encountered two veins were shown in the face, a narrow vein about ¼-inch in width accompanying the main vein, which was one to two inches in width. Both veins were faulted four inches to the north by a horizontal fault carrying calcite. This flat calcite vein, near the intersection of the nearly vertical veins, carries some secondary ruby silver. By February, 1921, the shaft had reached the 160-foot level. In sinking from the 70-foot level a second vein was encountered in the shaft at 105 feet on the south wall, and followed 125 feet, where it left the shaft on the north wall. This vein averages one and one-half inches in width and is high-grade.

A cross vein, showing some high-grade silver ore near the junction with the main vein, was also encountered in the open cut at the east end of the ore shoot. It dips steeply to the west and also shows west of the shaft at the 30-foot level. Its junction appears to limit the ore shoot to the east.

The property is equipped with a power plant at No. 1 shaft. consisting of two locomotive boilers, a three-drill compressor and two hoists. A third boiler has been altered to an air receiver at No. 2 shaft to which air is piped from the power plant.

Murray Kennedy is manager and Neil Morrison superintendent of the property.

Miller Lake and Everett (*R. S. C. 102*).—This property, lying to the west of R. S. C. 101, was operated some years ago by the Miller Lake and Everett Mines, Ltd., and 8.35 tons of silver ore were shipped in 1910. The ore was taken from a long open cut on a series of silver-bearing veins striking north 35 degs. west. The ore was hand-sorted, and there are a few tons of mill rock on the dump at present, where fragments of diabase frequently show scales of native silver. Fissuring is pronounced on claims R. S. C. 101 and 102 in the vicinity of the north and south centre line.

Barbara.—During parts of 1915 and 1916 some exploratory work was done on the Barbara property, situated to the north of Lake Irene. Several veins of quartz and calcite show on the surface. A strong vein on claim S. W. 8, striking N. 15 degs. E., has been trenched for several hundred feet, and consists of calcite and quartz, from an inch to two inches in width, carrying copper pyrites and bornite. A little native silver shows in seams in the very coarse, gabbro-like diabase. A shaft was sunk to the 100-foot level, and some crosscutting done on the level to intersect veins. The veins are located well within the diabase sill. The sedimentary rocks, one-quarter of a mile south around Lake Irene, lie on the sill.

Some smaltite and silver occur in veins on claim S. W. 18, south of Lake Irene.

Nicol Township

Big Four.—The Big Four consists of four mining claims, W. D. 961 to 964, situated one-half mile northeast of Gowganda lake. There is a great assemblage of rocks, consisting of Keewatin iron formation and green schist, quartz-porphyry, older diabase dikes, Cobalt series conglomerate and later diabase dikes. The diabase sill is not exposed on the property.

A vein, carrying calcite, cobaltite, iron pyrites and galena, was found on claim W. D. 962. It strikes N. 14 degs. E. and dips 30 degs. E. An open-cut about 20 feet in length was made along the vein, disclosing a width of 5 to 6 inches of material carrying much bloom and cobaltite. This showing is cut off by a diabase dike to the south. To the south of the dike, which is 50 feet wide, there are also some small showings of bloom. The vein or lens carrying the cobaltite occurs in iron formation, here represented by a silicious rock resembling chert, which for four feet above the vein is much stained with iron rust. A sample from the vein carries no gold and 8 ounces of silver per ton. A shaft sunk at a point 50 feet east of the outcrop of the vein intersected the low dipping vein which showed the same mineralization.

Some prospecting was also done on rusty silicious iron formation three chains northeast of the shaft. This work indicated a mass of solid iron pyrites in the iron formation lying between two north-south diabase dikes 9 feet apart and having a footwall of quartz-porphyry dipping 60 degs. N. Toward the north the iron pyrites, about 6 feet wide, becomes leaner, grading into silicious iron formation. The area immediately beyond the two dikes of diabase is drift-covered, and may conceal the extension of the sulphide band. A sample of the iron pyrites carries 41.35 per cent of sulphur. The silicious iron formation, carrying disseminated iron pyrites, contains no gold.

Castle, R. S. C. 106 and R. S. C. 92 (652).—Considerable exploratory work has been done on these claims by the Trethewey Silver-Cobalt Mine, Limited, with a view to prospecting the diabase formation which occurs beneath the Keewatin. These claims are situated just northwest of Miller lake.

A shaft was started in Keewatin on claim R. S. C. 106 and sunk to the 300-foot level. The diabase was first encountered at 90 feet, and from this depth to 130 feet the shaft was partly on both formations, showing a nearly vertical contact for this distance. Below this the shaft was entirely in the diabase, and a cross-cut 400 feet in length to the north of east was run to the contact, indicating a general dip of contact of 20 degs. from 130 feet in the shaft. The contact was further ascertained, in a long drift extending 500 feet to the north of the cross-cut, to be 15 N.E. Consequently at this horizon the diabase dips gently under the Keewatin. A calcite vein, striking north and south and dipping steeply to the west, was discovered 130 feet from the shaft, and drifting on the vein for about 230 feet has been done on the 300-foot level, and also on the 360-foot level, which is connected with the upper level by a steeply inclined winze on the vein. This vein carries in places some native silver together with smaltite, niccolite, native bismuth, copper pyrites and pyrite, and some quartz. Several strong faults dipping 30 degs. N.E. were encountered in the workings. One of these displaced the vein 20 feet on the 300-foot level. Several other calcite veins were also discovered. One of these showed a width of six inches in a cross-cut west from the main vein, while another was encountered 400 feet from the shaft in the long cross-cut, near the Keewatin contact. This vein of calcite up to four inches wide carries some smaltite.

Chapelle Claim H. R. 715 (195).—This property lies to the east of Leroy lake, including part of the lake. The rock exposed on the surface is nearly all sill diabase, with a small amount of Keewatin near the northeast corner post. In October, 1919, C. L. Campbell and W. H. Fairburn, who had optioned the property, began work on it by continuing the sinking of a shaft that had been begun some years before. This shaft is on a strong aplite dike and calcite vein. Some high-grade silver ore was encountered by the former operators at 48 feet, and again in the drift at the 85-foot level. Small amounts of silver had been found frequently while sinking the shaft and running the drift. Exploration showed that the vein, which strikes south 20 degs. west when drifted on to the south, was faulted 55 feet to the southeast. This fault which dips 60 degs. northeast contains drag vein material and also that of an aplite dike. In the face of the drift beyond the fault, there is a 4-inch vein of calcite and two mineralized aplite dikes of 1½ and 4 inches respectively. Specimens on the dump show calcite and aplite with copper pyrites, bornite, iron pyrites, and some smaltite and niccolite.

A number of veins were located on the surface by means of trenching in previous years, but most of these are now concealed by sand filling in the trenches. These veins occur in the diabase, which rises as a sill from the northwest, having the same relation to the Keewatin area northwest of Leroy lake as the diabase to the northwest of Miller lake, that is, it dips under the Keewatin. Owing to trouble over the option, work was discontinued on this claim in November, 1919.

Collins Claim (T. C. 220).—This claim, on the west side of Leroy lake, shows exposures of Keewatin tuffs and greenstone intruded by dikes of diabase. The Keewatin rocks, where banded, strike N. 60 degs. E. A vertical shaft, started on the east contact of a diabase dike with banded tuff, where there is a vein of calcite with quartz, copper pyrites, iron pyrites, and some smaltite and niccolite, has been sunk to the 300-foot level. A station was cut on the 180-foot level, also at the 300-foot level, where exploration will be carried on.

The vein on the surface is somewhat lens-like, and is four inches in width 100 feet south of the shaft, being located in places along the contact with the diabase. It was found to dip from the shaft at 50 feet; below 80 feet the shaft is entirely in the diabase dike. At 165 feet a second vein was encountered, averaging four inches in width and dipping from the shaft at 180 feet. Some native silver is reported to have been found in this vein. Distant 375 feet north of the main shaft, there is another shaft 20 feet in depth on the west contact of the diabase dike, where a vein about three inches wide contains minerals similar to those previously mentioned; native silver is found occasionally in this vein. The area of Keewatin overlies the diabase sill that outcrops on the east side of Leroy lake and to the south along the road. The bottom of the 300-foot shaft should be near the contact with the diabase sill provided the dip is approximately 30 degs. W., as indicated at the surface. F. H. Collins is manager.

Hart Claims.—The Hart claims, R. S. C. 135 and 136, were under option for a part of the year 1920. This property is favourably located along the hanging-wall contact of the sill diabase with the Keewatin, the sill outcropping on the southerly claim and the southwest part of the northerly claim. A shaft was sunk to the 100-foot level on a strong calcite vein. The vein strikes N. 23 degs. E., is nearly vertical and averages about four to six inches in width. Masses of vein material from the drift show abundant copper pyrite, bornite and pyrite. A little silver is reported from the vein. When visited in September, 1920, the drifts had reached 80 feet and 25 feet, north and south of the shaft respectively. A number of calcite veins are exposed on the surface.

Silver Bullion.—The Silver Bullion property is situated at the northeast end of Leroy lake. It includes two claims on each of which a shaft has been sunk. The easterly claim, W. J. 1, formerly called the Dodds, contains outcropping of schistose Keewatin greenstone. Near the south line of the claim a vein, carrying native silver, smaltite and native bismuth, with strike nearly east and west, was discovered. An open-cut was made on the vein by former operators, the cut being carried to a flat slip beyond which no work was done. A few bags of silver ore were taken from the open-cut. Further work by the Silver Bullion Company showed the lower extension of the vein to be faulted four feet to the north. A shaft was put down on the vein to a depth of approximately 50 feet by means of hand steel. The work showed a succession of faults and slips, the vein being displaced a few feet north or south, with the greater movement to the north. The greatest throw is at the bottom of the shaft where the lower part of the vein is displaced six feet to the north. At 30 feet in the shaft the vein is six inches in width. Segregations of silver, smaltite, niccolite and bismuth were encountered in the calcite vein. A plant, consisting of a 100-h.p. boiler, a 6-drill compressor and a 6 x 8-inch hoist, was installed in the fall of 1920. The property was closed down shortly after, but it is expected operations will be resumed early in 1921.

The shaft on the westerly claim is located on a small island where there is an outcropping of Keewatin. It was sunk 100 feet, and the area under the lake was prospected by a cross-cut to the south. A two-inch vein of calcite was encountered 90 feet to the south of the shaft. This vein showed a little smaltite. The shaft was abandoned for the new shaft on the Dodds vein. R. C. Gamble is manager of the property.

Walsh.—The Walsh claim (R. S. C. 98) includes a small portion of the shore of Miller lake and takes in some land under the lake itself. During parts of the years 1917 and 1918 the property was under option to the Crown Reserve Mining Company. A shaft previously sunk 60 feet deep was continued to 200 feet. It is located on the south part of the claim, near the shore of the lake. From the shaft drifts were run northward on the 100- and 180-foot levels. A little silver ore was indicated on the 100-foot level. The calcite vein is said to be strong on both levels.

During the first part of 1920 the Walsh Mines, Limited, reopened the mine and continued prospecting, chiefly on the 180-foot level, but the result was not very encouraging. The drift was extended to the contact, where the Keewatin was found to overlie the sill diabase at an angle of

35 degs. E. The geological conditions would seem favourable for prospecting the diabase below the Keewatin, since the work has indicated some silver deposition.

The shaft was started in a north-south diabase dike, about 30 feet in width, that intrudes the Keewatin schist. The dike carries some phenocrysts of feldspar, and is believed to be of pre-Cobalt series age. It also carries some calcite veins with north-south strike. Both the dike and the Keewatin intruded by it overlie the diabase sill, but the depth in the shaft at which the sill was encountered is not known, as the workings were filled with water at the time of visit and no examination could be made.

The property is equipped with two 40-h.p. boilers, a small compressor and hoist and has good camp buildings.

Lawson Township

Considerable exploratory work has been carried on at various times on properties in the vicinity of Calcite lake. During 1920 none of these properties was in operation.

Bishop.—The Bishop Mining Company operated mining claim L. O. 313, adjacent to the east shore of Calcite lake. As the shore of the lake is precipitous, it was possible to carry on exploration by means of an adit level eastward into the ridge. The adit is 515 feet long and at 216 feet from the portal, north and south drifts, 464 feet and 177 feet respectively, were made on a calcite vein, which showed a little silver ore here and there but no continuous ore-shoot.

No. 1 winze, 300 feet from the portal, is 18 feet deep, and No. 2 winze, at the end of the main drift,is 100 feet deep with 100 feet of work at the lower level.

The plant consists of two 60-h.p. boilers, a 6-drill compressor and hoist.

Caleta.—Mining claim L. O. 357 was first operated by the Calcite Lake Mining Company, and later by the Caleta Mining Company. The Mining Inspector's report for 1914 states that shaft was sunk 285 feet with 340 feet of cross-cutting and 310 feet of drifting, mainly at the 200-foot level. Some native silver, smaltite and niccolite in calcite were encountered in the workings and a small shipment of silver ore made from the property.

The plant consists of two boilers, 40-h.p. and 60-h.p., a 3-drill compressor and an 8 by 10 hoist.

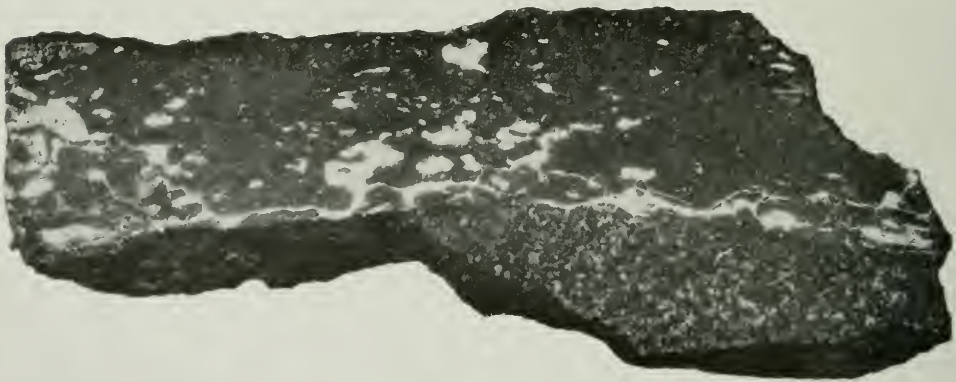
Powerful.—The Powerful prospect is situated about one mile southeastward from Calcite lake. The property has been worked intermittently for several years. Exploration has been carried on by means of a long adit level that has been run eastward into a prominent diabase ridge on claim H. R. 397. The contact with the quartzite is drift-covered a short distance west of the portal of the adit, consequently the attitude of the contact is not known. The following description of underground work is taken from the Mining Inspector's report for 1916:

> A tunnel runs northeast into a hill and 700 feet of cross-cutting and drifting has been done at this level. From the east end of the tunnel a raise 158 feet long at an angle of 45 degrees has been driven to the surface. A winze has also been sunk near the face of the tunnel. It is 145 feet deep and is vertical for 90 feet and inclined at 70 degrees for the remainder of the distance. From this winze three levels have been opened up and the following work done: At 50 feet below the tunnel level about 75 feet of drifting and cross-cutting; at 90 feet below tunnel level 400 feet of drifting and cross-cutting and 30 feet of raising; at 145 feet below tunnel level 85 feet of drifting.
>
> The machinery on the claim consists of a Leonard boiler, 80-h.p.; a Laidlaw-Dunn-Gordon compressor, 14 by 14 by 12 inches, a Jenckes hoist 6 by 8 inches.

Milner Townships

Bishop.—The Bishop Mining Company operated a group of claims lying northwest of the northwest arm of Gowganda lake. A shaft on claim T. C. 136 was sunk 130 feet with drifting of 20 feet. The surface of the diabase exposed here is near the top of the sill. A small remnant of the overlying sediment, partly altered to adinole, occurs along the road north of the shaft. The diabase is well fractured and some silver occurs in veins at the surface, but underground operations were discontinued before sufficient lateral work was done to determine the possibilities of the veins underground. The veins have an approximate N.E.-S.W. strike and are nearly vertical. Some of the vein material on the dump shows bloom and flakes of native silver.

Crews-McFarlan.—The Crews-McFarlan mine was not in operation during 1920. It includes four claims, H. F. 221-224, situated near the south end of the southwest bay of Gowganda lake. The property has been worked intermittently since the fall of 1908, following the spectacular discoveries of native silver by two prospectors, F. McIntosh and S. McLaughlin. Under the name of the Bartlett mine, it was first operated by the Bartlett Mines Company, later by the Scottish Nigeria Mining Company, and finally by the Crews-McFarlan Mining Company.



Specimen of polished ore from the Crews-McFarlan (Bartlett) mine showing calcite vein, one inch in width, with adhering diabase wall. Native silver is shown in the light parts in the form of veinlets and patches in the calcite and along the contact. A little argentite and copper pyrite occur with the silver.

The property is equipped with a plant consisting of two 80-h.p. return tubular boilers, a 12-drill compressor, two hoists and a machine shop.

Shafts Nos. 1 and 2 were sunk by the original company and later operators have increased the underground workings.

No. 1 shaft, at which the most extensive work has been done, is on claim H. F. 222. It is in the lower part of the diabase sill about 500 feet west of the outcrop of the underlying quartzite which dips about 45 degs. westward. The shaft is 300 feet deep with workings on three levels, totalling over 1,000 feet. It was started on a high-grade ore-shoot that extended downward only 25 feet. The ore was massive smaltite and native silver in calcite from two to three inches in width. A series of open cuts were made southwestward from the shaft on a number of lenses of ore over a distance of 350 feet. The chief gangue material with the ore is calcite, but lenses of the mineral occur with an aplite dike along which the open cut was made. The aplite and diabase wall rock are much fractured in places, and contain sheets and scales of native silver. Some of the vein material carries considerable copper pyrites.

The high-grade ore consisted of smaltite with native silver and argentite. Some of the diabase and aplite carrying abundant leaf silver is of good milling grade. Most of the ore shipped from the property came from the open cut.

No. 2 shaft, located in the southwest part of the property, was sunk 100 feet and drifting and cross-cutting amounting to 360 feet done. The work did not indicate commercial ore. A narrow vein, about one-quarter of an inch in width, carrying massive smaltite and silver, was encountered in the workings.

Directly west of the shaft there is an aplite dike which showed a lens of calcite with smaltite and silver over a few feet. A shallow open cut was made along the lens of ore by the early operators and a few bags of high-grade material obtained.

The most recent work was done on claim H. F. 224 in the southeast part of the property where several veins were located by trenching. One of these, having a width of one inch, contained a shoot of high-grade ore along which an open cut was made and a quantity of high-grade ore obtained. A shaft, No. 3, situated 40 feet to the north of the open cut and near a second vein, was sunk to a depth of 75 feet and at 50 feet a crosscut made southwestward to the silver-bearing vein on which some exploratory work was done and also on the vein located near the shaft.

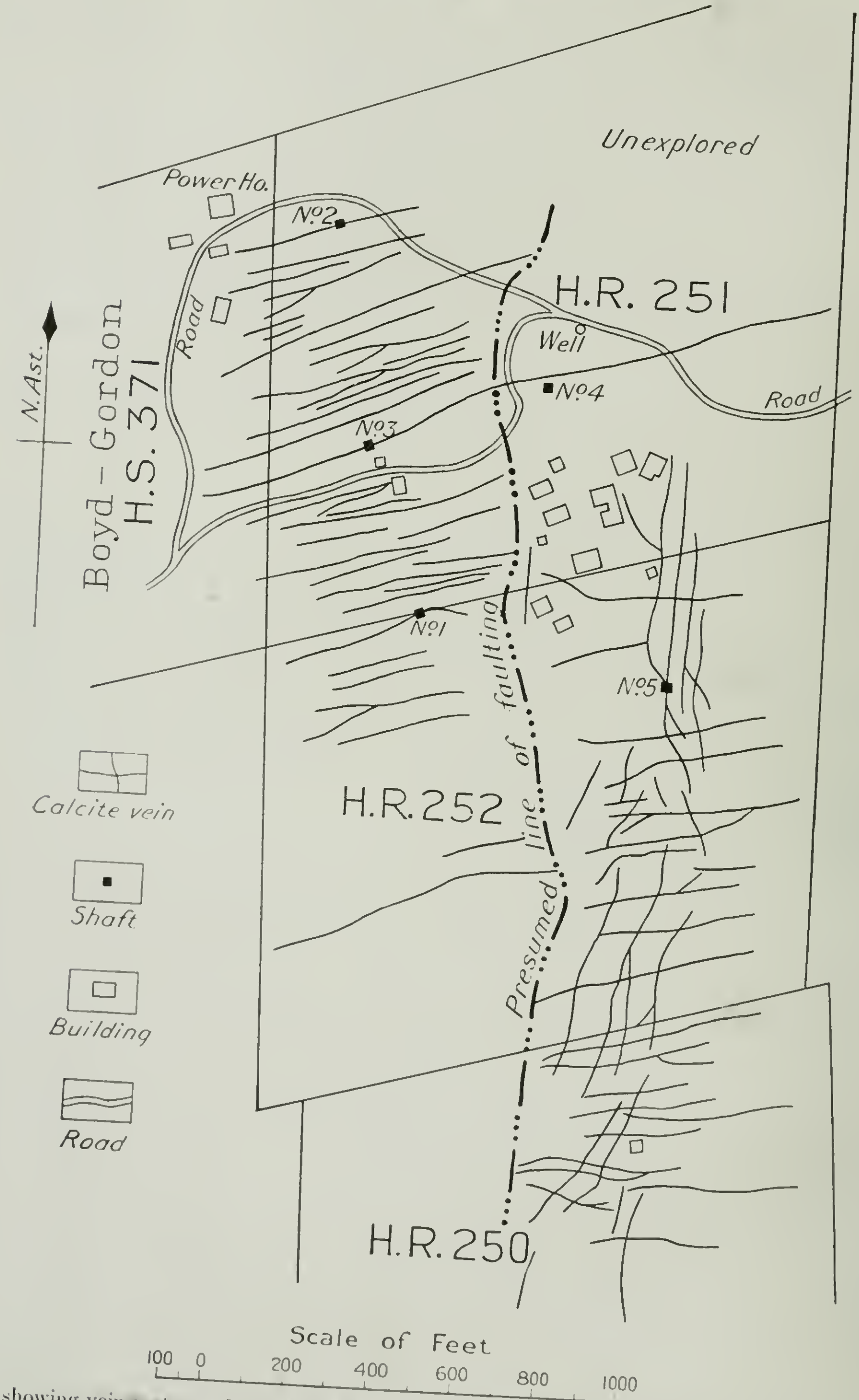
Some silver ore was encountered on this level, but the outlook was not sufficiently encouraging to continue operations under the high cost of operation.

The ore obtained from the open cut was of peculiar appearance in so far that most of the calcite vein matter is very dark, almost black in colour. This dark colour is evidently due to very fine particles of magnetite disseminated in the calcite. Some of the high-grade vein shows massive native silver with argentite in calcite, the silver occurring in veinlets and masses generally near the contact with the diabase. Other samples show massive smaltite with the silver minerals.

Four chains southeast of the shaft there is a 2-inch aplite dike, showing calcite with niccolite and smaltite, on which a shallow pit was sunk.

Hewitt.—For some years previous to 1920, the Hewitt Lake Mining Company operated a group of claims lying west of Gowganda lake and one-half a mile north of the Mann mines. When visited in 1920 no work was being done, and the workings were filled with water. One shaft is reported to have been sunk to a depth of 300 feet with some lateral work, but no information is obtainable as to the silver bearing character of the veins. The Nipissing diabase is exposed at the surface, erosion having removed the overlying sediments from a part of it. Some small patches of sediment still show on the diabase sill, consequently the workings are in the upper part of the diabase where fractures would be looked for.

Mann.—The Mann mine is situated on a diabase ridge one-half mile west of the northwest arm of Gowganda lake. It includes a group of claims: H. R. 249-252, inclusive, staked by the Mann-Ryan interests in 1908, following a discovery of native silver by Robt. Mann. This discov-



Plan showing vein system at Mann Mines, reproduced from sketch furnished by Geo. R. Rogers. The vein in which most work has been done, and from which most of the ore was produced, is No. 3.

ery of silver was made on a bluff of diabase, where a decomposed calcite smaltite vein, about 3 inches wide, showed a rib of native silver protruding from the vein. The vein, known as the discovery or No. 1 vein, was traced several hundred feet by trenching to the west, with several showings of native silver along the surface.

The principal vein is No. 3, which has produced almost all the ore shipped from the mine. The vein has been traced 1,300 feet by trenching, while open-cuts and underground operations indicated several ore-shoots. No. 3 shaft has been sunk to a depth of 200 feet with levels at 80 feet, 120 feet, and 200 feet, while No. 4 shaft, located 350 feet to the east, was sunk to the 80-foot level and connected on this level with No. 3 shaft. Most of the underground work was done on the 80-foot level, where three stopes were opened up to the west of No. 3 shaft and one stope 100 feet west of No. 4 shaft. The easterly stope connects with an open-cut which was made just west of No. 4 shaft. This cut is 30 feet long, and about 14 tons of high-grade ore were taken from it. The ore-shoot pitches westerly at 45 degs., and did not extend below the level. An ore-shoot near No. 3 shaft also shows a pitch to the west, while on the 80-foot level it was 50 feet in length. The ore-shoot was stoped from about 15 feet below the level to near the surface. A third stope was made on the vein 130 feet west of No. 3 shaft, and was also carried from 15 feet below the level to near the surface. The shoot was about 60 feet long on the level. A fourth small shoot about 15 feet in length was found near the end of the west drift on the 80-foot level. High-grade ore was also encountered on the 120-foot level, 200 feet west of No. 3 shaft; 450 feet of drifting along the vein was also done on the 200-foot level of No. 3 shaft.

The vein is about one inch to 5½ inches in width. The ore was hand-sorted at the surface and bagged for shipment. Twenty tons of low-grade ore were treated at the Millerett mill in 1912, and from this 715 ounces of fine silver were produced.

The high-grade ore is chiefly native silver with smaltite in calcite. Forty-eight tons of high-grade silver ore, from which were recovered 99,076 oz. silver, were shipped from the property.

One shipment averaging 2,000 ounces per ton silver contained $2.00 per ton in gold.

On the Mann property there are two pronounced north and south ridges. On the westerly ridge all of the veins have a strike of a few degrees north of east, whereas on the easterly ridge there are a number of veins which strike nearly north and south, in addition to a number which strike easterly and westerly. This has suggested the possibility of faulting. The underground work proved a strong north-south fault dipping 45 degs. W., with a crushed zone about four feet in width. The westerly part of No. 3 vein was displaced 15 feet to the south by this fault.

The Boyd-Gordon mine, H. S. 371, was taken over by the Mann mine in 1912.

George Rogers was in charge of the Mann property during most of the development of No. 3 vein from which the shipments were made.

The property was closed down in 1914.

Northclff—The Northcliff prospect is situated at the north end of the northwest arm of Gowganda lake. The property consists of about 160 acres, the principal claim of which is J. S. 282. The veins are in the Nipissing diabase, which occurs as a high ridge along the northeasterly shore of the lake. The ridge rises abruptly from the water's edge to an elevation of 125 feet. The relationship to the conglomerate is seen along the north line of J. S. 282, where the diabase underlies the conglomerate at 60 degs. W.

The property was operated from the fall of 1919 for about one year. Some surface work was done on a series of veins on the top of the ridge. An open cut 25 feet long was made on a calcite vein with strike N. 20 degs. E., which averages from about an inch to three inches in width. Some specimens showing crystallized smaltite and silver were taken from the open cut. The vein is faulted at the south end of the cut, ten feet westward. Shallow cuts and trenches were also made on some other fractures near the open cut. Most attention was, however, given to driving a tunnel eastward into the hill from near the water's edge. This work was stopped before it was certain that the underground extension of the surface vein carrying silver had been intersected. Several calcite veins, from an inch to three inches in width, and a stringer of quartz showing some silver, were cut in the tunnel, but no drifting was done on them.

The tunnel is about 285 feet in length. The work was accomplished by using steam drills, but this was not found satisfactory, and it is expected when conditions improve that a compressor plant will be installed. Norman Dye is manager of the property.

Reeve-Dobie.—The Reeve-Dobie mine, which has been operated intermittently since 1908, was closed down in the fall of 1920. It has been worked by various interests. The original discoveries were among the most spectacular in the camp, and from open-cuts along short ore-shoots some very rich silver ore was shipped. The early work consisted in prospecting for high-grade ore which was found to occur in a number of short shoots along a mineralized zone about 700 feet in length. Most of the high-grade ore was taken from a number of open-cuts. Later a mill was erected which ran for a short time treating diabase carrying minute veinlets containing native silver. The mill was reopened in 1919, a flotation plant added and ore from an open-cut or glory hole to the south of the shaft was treated. The ore was dropped to the 50-foot level and trammed to the shaft. The mill rock was said to carry from 30 to 35 ounces of silver per ton. Underground operations were carried to the 200-foot level and considerable drifting and crosscutting was done. A number of strong faults were encountered in the workings.

Very little work has been done on the westerly side of the property where there is much fracturing.

South Bay.—The South Bay Mining Company did exploratory work several years ago on claims H. S. 723 and H. S. 724. They also sank a shaft to a depth of 100 feet on the O'Brien claim H. S. 602, lying to the west. There is a series of five calcite-quartz veins near the shaft, with a general strike of NW.-SE., running from H.S. 602 to H.S. 723. In addition to the shaft, several large open-cuts were made on veins. A description of the property is given in a report on the Gowganda Silver Area: (1)

> Active development was in progress at that part of the property which adjoins the southeast claim of the Bartlett mine when visited in October, 1912. A great amount of surface trenching had been accomplished, and open cuts had been made on some of the veins. Smaltite, niccolite and silver were found at different points. At one place 90 feet south of the shaft some high-grade ore has been taken from a cut about 20 feet in length. The shaft was down 100 feet, and a cross-cut was being run to the south to intersect three N.W. and S.E. veins which showed on the surface. A north cross-cut

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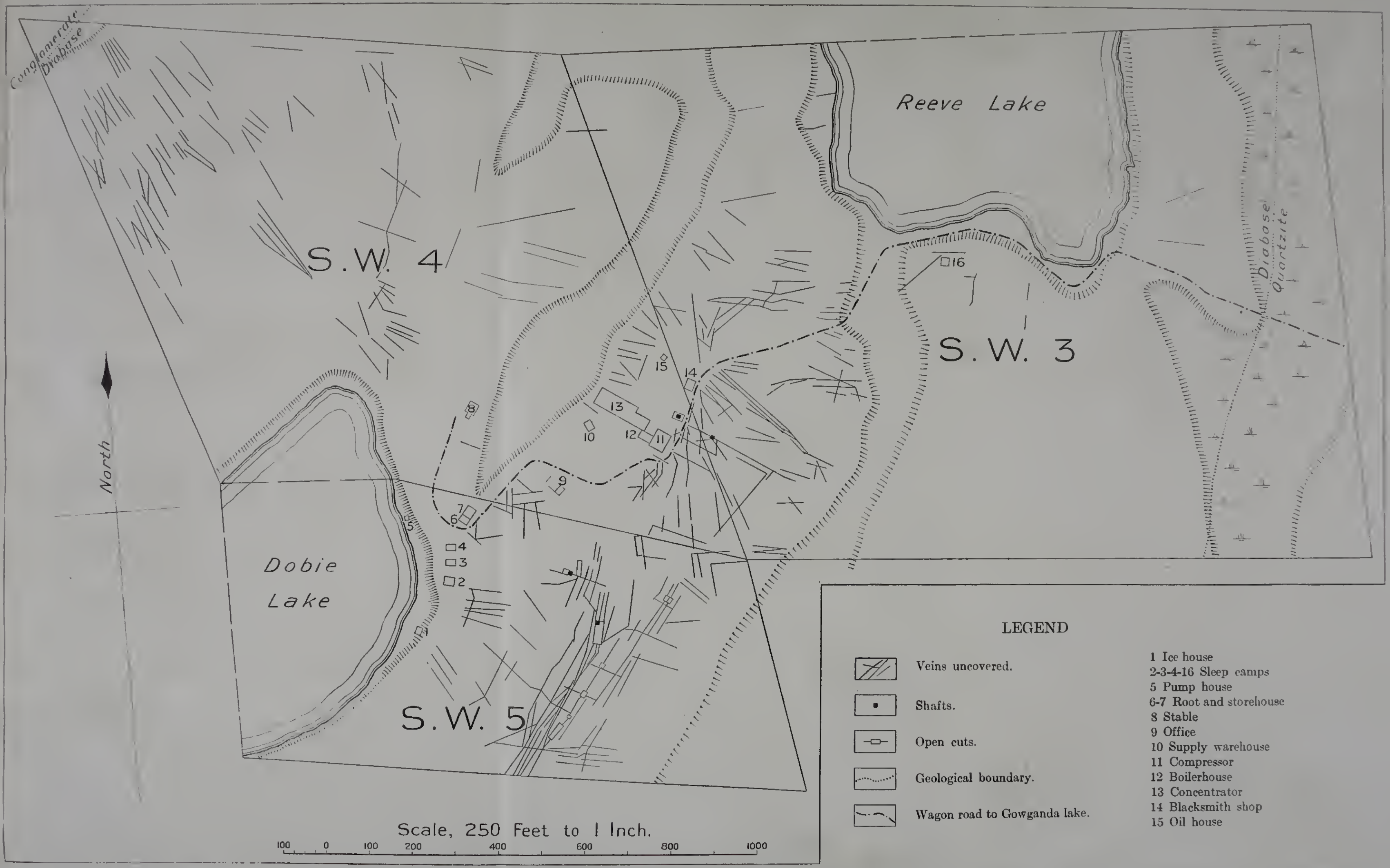
(1) The Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming, Ont. Bur. Mines, Vol. XIX, 1913, PART II, p. 186.



Plan showing vein system at Reeve-Dobie mine, reproduced from mine plan furnished by the company. The principal workings are on the NE-SW veins in the southeasterly part of the property.

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(1) The Cobalt-
Mines, Vol. XIX, 1913,

was also being run towards a vein with strike N. 60 degs. W. which crosses from the Bartlett property. A 50-foot shaft had also been sunk just south of the north boundary line, on a vein parallel to the one just mentioned. The material on the dump consists of diabase, with aplite and calcite. Native silver and argentite occur in some of the vein material. Part of the vein about one inch in width consists of crystallized epidote and quartz carrying silver and argentite.

Columnar structure is quite pronounced in the diabase, and along the joints veins have been formed, suggesting the filling of cooling cracks. Some of the country rock is quite reddish and coarse-grained, and traceable into the dark grey diabase. Much of the reddish rock adjoining the veins is greatly stained with cobalt and nickel bloom.

Van Hise Township

Alpine (*Gamey-Thompson*). —The property of the Alpine Silver Mines is situated in the west part of Van Hise township to the northwest of Spawning lake. Here there is a north-south ridge of diabase about 2½ miles in length, reaching an elevation of 200 feet above the surrounding plain which consists of sediments of the Cobalt series overlain in part by sand and gravel.

A series of aplitic veins was discovered on the diabase ridge, along which a great amount of trenching accompanied by the sinking of shallow pits and two shafts to moderate depts, has been done. Associated with the aplite dikes are lenses and veinlets of calcite which occur in different parts of the dikes, as shown along the surface. Most of the work has been done on claim H. R. 458. The aplite dikes vary from about 6 inches to one foot in width.

A northerly trench is along an aplite dike for 140 feet, showing veinlets of calcite, and aplite impregnated with calcite, with frequent occurrences of native silver. Along one streak the calcite is two inches in width on the north wall of the dike, which strikes N. 83 degs. W.

A second aplite dike has been followed for 450 feet by means of trenches. It has a strike of N. 20 degs. E. for 120 feet at the northerly end, and a strike of N. 60 degs. E. for the southerly portion, while the dip is 80 degs. W. The best surface showings occur north of the 30-foot shaft. Some rich nuggety silver ore was taken from an open-cut just north of this shaft. The matrix is also aplite, with lenticular calcite structures. A third dike occurs at the southwest end of the second dike, and has been followed for 300 feet. Just south of the intersection of the dikes there is some high-grade ore.

A tunnel 575 feet in length has been driven from the base of the hill westward to intersect the first dike at a depth of about 170 feet. The aplite dike was drifted on underground for 80 feet before work was discontinued.

A shaft was sunk on another aplite dike with NW-SE strike to a depth of 29 feet.

The diabase sill has been fractured with the formation of intersecting aplite dikes, along which segregations of calcite carrying native silver have been formed at several points on the dikes.

The columnar jointing planes exposed in the long tunnel would suggest that the diabase is in the form of a sill rising from the east.

A power plant consisting of a 60-h.p. boiler and 3-drill compressor was installed recently and exploration will be carried on in 1921.

E. J. Thompson is superintendent.

Hedlund.—During 1920, L. O. Hedlund was prospecting T. C. 141 and an adjacent claim to the east, situated a mile and a half north of the northwest arm of Gowganda lake. These claims are around what was formerly known as McLaughlin lake, but which has been drained by the blasting of a rock ledge at its lower end in aid of the waterpower supply of Gowganda lake, the lake now being represented by a marsh. Considerable work was done on the west side of the marsh in the sill diabase, and also on the easterly side, in a dike of diabase which intrudes the conglomerate. The best results were obtained west of the marsh, where there are quartz veins showing some native silver. A shaft has been sunk to a depth of ten feet at the junction of a quartz vein two to three inches in width with strike NE.-SW., and narrow transverse stringers of aplite. The quartz vein with offsets has been traced southwesterly several hundred feet. It has a banded structure showing scales of native silver in the white quartz, together with copper pyrites, galena and a little niccolite at the shaft. A little cobalt bloom was also seen in the narrow veins near the shaft. The transverse veins at the shaft also show a little native silver in the aplite.

The sill diabase outcrops at a few places in the marsh, but was not observed in contact with the older rocks that occur to the east of the marsh. On the west side of claim, T. C. 141, the diabase underlies the conglomerate at a high angle.

Charters Townships

Garvey.—The Garvey claim, E. D. 123½, situated west of the Montreal river, in the south part of Charters township, was being prospected during the summer of 1920 by the Garvey Bros. A number of veins were discovered on a knoll of diabase near the west line of the property.

The veins vary greatly in strike, and are more or less connected as revealed by the trenching. The vein in which most silver was noted is about an inch to two inches in width, strikes N 60 degs. E and was traced for 125 feet. In part of the distance there is an open fissure, but toward the easterly end of the trench, for a distance of 30 feet, there are showings of high-grade ore, consisting of silver and smaltite, some of the silver being in the black decomposition products of cobalt and nickel minerals. A second vein, 13 feet northwest, strikes N 48 degs. E and contains aplite six inches wide together with calcite. Fragments of the aplite show scales of native silver. Cobalt bloom can be seen along the walls of several other veins, represented by open fissures for six inches or more. The discoveries having been so recently made, practically no work has been done beyond trenching, so that more time will be required to prove their economic value. The greatly fractured diabase knoll affords a promising location for considerable exploratory work.

Haines.—The Haines claim, H. R. 439, is in Charters township, one-half a mile south of the Garvey claim and near the south boundary of the township. Some work was being done in a shaft on a vein which strikes N 45 degs. E. The shaft was down 11 feet, and for six feet from the surface showed a lens of calcite carrying some silver and smaltite, while at the bottom of the shaft there is a thin seam of calcite,

Work was also done by the same interests on claim G. G. 2606 in Donovan township, where a shallow shaft has been sunk on a calcite vein from an inch to two and a half inches in width with a strike N 62 degs. E. The vein carries disseminated smaltite, niccolite, chloanthite and some native silver. The rock is a coarse-grained diabase showing some reddish granophyric interstices of quartz and feldspar.

Leith Township

Hudson Bay.—This property is in the southeast part of Leith township, and includes mining claims H. S. 695, 696, and 716. It was operated from 1910 to 1913, but has since been idle. Two shafts were sunk on silver-bearing veins on claim H. S. 716 and one shaft on claim H. S. 696. When visited in 1920 some of the veins could be seen at the shafts near the surface, while some heavy smaltite silver-bearing ore was picked up on the dump. It is reported that about six tons of silver ore were taken from the workings, chiefly from shaft No. 2.

At No. 1 shaft, which was sunk 94 feet with a drift of 128 feet, there is a strong calcite vein 7 inches in width in addition to some narrow stringers. Some massive smaltite, 20 inches in width, is reported from the open-cut.

No. 2 shaft was sunk 110 feet with drifting of 274 feet. The vein showed near the collar of the shaft a width of two inches with a dip of 80 degs. NW.

No. 3 shaft was sunk 214 feet with drifting amounting to 362 feet on the 76-foot level, and 359 feet of drifting and cross-cutting on the second level. The vein in shaft No. 3 is reported to be from one inch to four inches wide, and in places to carry high values in silver. Four veins were met with in drifting. two of them showing native silver.

It is expected that this property will be reopened when conditions of mining and transportation are improved.

Silverado.—The Silverado Mining Company is operating a group of 14 claims located in the southeast part of Leith township and the southwest part of Charters township, most of the claims being in Leith. The property is adjacent to the Hudson Bay mine. Most of the exploratory work has been done on claim H. S. 693, where several veins have been located. Nos. 1, 2 and 3 veins have a general N-S strike. Some trenching and shallow pits have been made on these veins, indicating the occurrence of smaltite, niccolite, copper pyrites, aplite and calcite. Native silver was found in No. 1 vein, and also in No. 4 vein, which strikes more nearly east and west. Some very high-grade silver ore an inch in width was obtained from a pit on No. 4 vein.

A shaft has been sunk on No. 3 vein to a depth of 100 feet, and a drift to the north and a cross-cut to the southwest were begun to intersect veins that outcrop at the surface.

The veins are in the Nipissing diabase, with which conglomerate and quartzite of the Cobalt series form the contact. On claim G. G. 4149 the sedimentary rock adjacent to the diabase has been altered to adinole, showing rounded spots. The top of the sill is exposed in the locality.

The plant consists of an 125-h.p. return tubular boiler, a 7-drill compressor, hoist and pumps. A saw-mill has also been erected to prepare lumber for the mine buildings.

Donovan Township

Duggan.—Some work was done on claims H. R. 720, and T. C. 418 during part of 1920 by Howard Duggan. These claims are along the east branch of the Montreal river in Donovan township. Veins were discovered by earlier stakers in 1909, and in succeeding years considerable prospecting was carried on by means of trenches and open-cuts. On claim H. R. 720 there is a calcite vein three inches in width with strike N. 71 degs. W., that has been traced for about 400 feet on the claim and on adjacent claim to the northwest for 200 feet. A little native silver, smaltite and niccolite were found in places in the calcite. A pit 10 feet deep was sunk on the vein 150 feet east of No. 4 post. Just west of the pit is another vein, three inches in width, showing calcite with a little smaltite, crossing the longer vein.

Two veins of calcite carrying bloom and copper pyrites occur in the northwest part of claim T. C. 418.

Wilder.—Claims G. G. 3541 and 3542 , located in Donovan township, a quarter of a mile east of Collins lake, were explored by Frank Wilder during part of 1920. An open-cut 28 feet long and nearly five feet deep was made along a calcite vein varying in width from half an inch to two inches, and in strike from N. 65 degs. E. to N. 45 degs. E. A few segregations of native silver and smaltite together with some niccolite in one place occur in the calcite vein. Two branch veins, one two inches wide and the other from one inch and a half to four inches wide, are shown near the southwest end of the open-cut. Two of the showings of silver are near the intersections with the main vein. Seven feet north of the east end of the cut on the main vein a second vein, varying in width up to two inches, has been followed northeasterly for 175 feet. The wall rock of the veins is Nipissing diabase.

Morel Township

Bishop.—During part of 1920 Wm. Shields carried on exploratory work on claim L. O. 305 lying to the northwest of Bloom lake. A vein with east-west strike and varying in width up to six inches, was trenched for several hundred feet. The vein filling is calcite which carries in places smaltite, together with some massive bornite and native silver. The wall rock is Nipissing diabase. The shaft was sunk to a depth of 50 feet.

Corkill Township

The township of Corkill came into prominence after the discovery of native silver on the Kell claims, G. G. 3786, 3449, about 12 miles southeastward from Gowganda. The locality is reached by a wagon road which leaves the main Elk Lake-Gowganda road about one-half a mile west of Long Point lake. From Gowganda a canoe route up the east branch of the Montreal river to the lower end of the third portage can be used. From here there is a trail eastward by way of Steele lake and partly following the south boundary of Charters township to Corkill township.

Corkill is largely covered with sand and gravel deposits of glacial origin, occurring in plains and gently rolling ridges. The township contains a number of spring lakes, the largest of which is Lady Isabel, locally called Beauty lake. This lake has beautifully clear water, has no surface outlet, and abounds in lake trout. Brook trout are found in several spring creeks in the area south of Long Point lake.

Geology

Several ridges of Nipissing diabase and Animikie quartzite outcrop through the drift. Of these the ridges of diabase form the chief topographical features, reaching in places 250 feet above the plain.

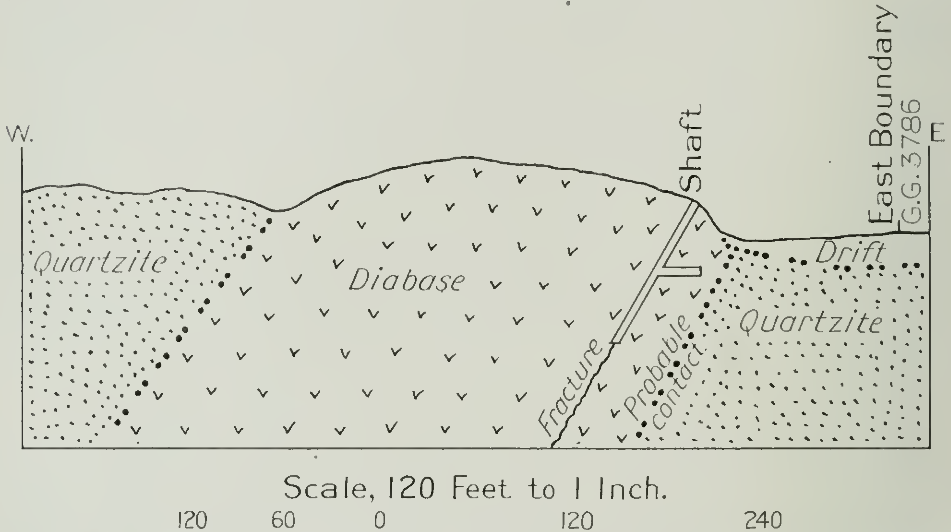
Diabase.—The diabase ridge in the southwest corner of the township was examined closely. Its structure is that of a highly inclined sill rather than a dike. The normal quartz diabase is dark grey, but in a few places was found to contain dark red spots which are chiefly acid plagioclase (albite) showing some differentiation not recognized in dikes. Microscopically, the rock has an ophitic texture, the laths of feldspar being partly altered to saussurite, and the augite partly to chlorite. Micrographic intergrowths of quartz and red plagioclase occur abundantly in the interstices of the specimen examined. The diabase resembles that of Gowganda, Elk lake and elsewhere, and is clearly in the form of a sill. An excellent contact of the overlying diabase and the quartzite occurs on the line between claims G. G. 4247 and 4326. The contact is well up the east side of a steep ridge that overlooks Shack lake and dips westerly at 55 degs.

Quartzite.—Quartzite of varied grain and colour is the only sedimentary rock found in the area near the silver discoveries. In this respect this area resembles Cane and Auld townships and the silver area near Maple Mountain.

Discovery of Silver.—Claims were staked as early as 1909, but little work was done until several years later. The discovery made by Hugh Kell and associates was of native silver in veins on a narrow diabase ridge on G. G. 3786 in the southwest part of the township. The first find was made in a number of loose fragments of diabase carrying sections of a calcite vein. Further exploration resulted in the finding of native silver in place at points along the easterly side of the ridge. Here there is a main fracture that roughly parallels the contact with the quartzite, dipping 55 degs. to 60 degs. westward. What appears to be the same fracture zone has been located by means of trenches and pits at intervals over several claims. The main fracture varies up to 18 inches in width. The principal constituents are calcite and quartz, carrying angular fragments of diabase and showing cobalt bloom in places along the surface. There are also roughly parallel veinlets of quartz and calcite, mostly on the footwall side of the main fracture, as well as subsidiary veins that run diagonally from the main fracture. In some of these latter high-grade silver ore was discovered.

Exploration of Kell Claims.—The property was optioned during 1919-20 to J. G. Smith, ex-Governor of Vermont. Well-constructed camp buildings and a steam power-plant were built on claims lying to the east of those carrying the silver-bearing veins. The steam plant consists of an 80-h.p. boiler, a 4-drill Ingersoll-Rand compressor and a 6 by 8-inch Jenckes hoisting engine. An inclined shaft, 58 degs., was sunk on the main fracture to a depth of 104 feet, and 275 feet of drifting on the 54-foot level and about 50 feet on the 100-foot level accomplished. A raise was also made from the 54-foot level to an outcrop of high-grade ore 25 feet south of the shaft. The diabase along the footwall in the shaft showed some native silver to the 100-foot level, and a little silver was encountered in the drift on the 54-foot level to the south of the shaft.

A small shipment of ore, 1,584 lbs., containing 1,620.9 oz. of silver, was made from an open-cut south of the shaft, together with a few bags from an open cut 700 feet north of the shaft. A number of prospecting pits have been sunk along the main fracture. From one of these, 200 feet south of the shaft, good specimens of the rare nickel sulphide, millerite, were obtained. An assemblage of minerals, including argentite, smaltite, niccolite, millerite, together with small quantities of magnetite, specularite and pyrrhotite, have been obtained from the calcite-quartz veins. The presence of the last three minerals indicates a high temperature of formation of the veins. Most of the ore shipped consisted of white calcite with native silver in scales, together with some argentite. Some heavy smaltite with native silver was obtained from an open cut north of the shaft. Work had been discontinued for two months when the property was visited in July, 1920, so that only the surface conditions could be studied. From information obtained and an examination of the surface, it was judged that the narrow subsidiary calcite veins on the footwall side of the main fracture afford the most promise for high-grade silver ore.



Cross section at Kell property, Corkill township, showing highly inclined attitude of diabase sill and shaft on fracture near footwall:

Kell (*G. G. 4124 and 4125*).—Mining claims G. G. 4124 and 4125, along the west shore of Lady Isabel lake, belong to Hugh Kell. The rock here is diabase, occurring as a N.W. and S. E. ridge outcropping through the drift. Unlike the fracture on the Kell claims previously described, the veins are transverse to the long axis of the diabase outcrop. They are largely of quartz with a ribboned structure. Calcite lenses occur with the quartz veins. Small particles of galena and copper pyrites are frequently seen. A little native silver occurs in the quartz and as scales in the diabase. A series of veins averaging one to three inches in width occur along the easterly base of the diabase ridge running back over the hill. At one place there are three in a width of 15 inches. A few shallow pits have been sunk on several veins, but many of the veins are unprospected.

South Bay Power Company

A hydro-electric power plant has been installed by the South Bay Power Company at the outlet of Hangingstone lake, where it discharges into Gowganda lake. The natural head is 58 feet, but by means of a dam this has been raised to 69 feet, 4 inches. The flume is 450 feet in length, most of the fall being near Gowganda lake. The drainage area of Hangingstone lake is approximately 39 square miles, and the present plant is a 250-horsepower installation.

II.—AULD AND CANE TOWNSHIPS

By A. G. Burrows

Location

The townships of Auld and Cane are in the district of Timiskaming about 20 miles northwest of Cobalt. The Montreal river flows diagonally across Auld, so that about half the township is in the Timagami Forest Reserve. Cane lies directly north of Auld, and the Elk Lake Branch of the Temiskaming and Northern Ontario railway traverses the northerly part of the township.

Means of Access

The mineral area is connected by a wagon road, about six miles in length, with Kenabeek station, situated in Henwood township. The southerly part of the area is readily reached from Latchford by gasoline launch to Indian lake, from which there is a mile portage to Lepha lake. From Lepha lake there is a good trail to the Triangle silver mines.

Topography

The prominent feature of the area is the winding diabase ridge that, in places, is 150 feet higher than the plain. The easterly part of Auld and a part of the south portion of Cane are quite rugged and rocky. Most of Cane has been taken up as farm land, the greater part of the township being suitable for agriculture. The country, except where cleared, burned or lumbered over, is well timbered with spruce, jack pine and other soft woods. Large quantities of spruce have been shipped as pulpwood.

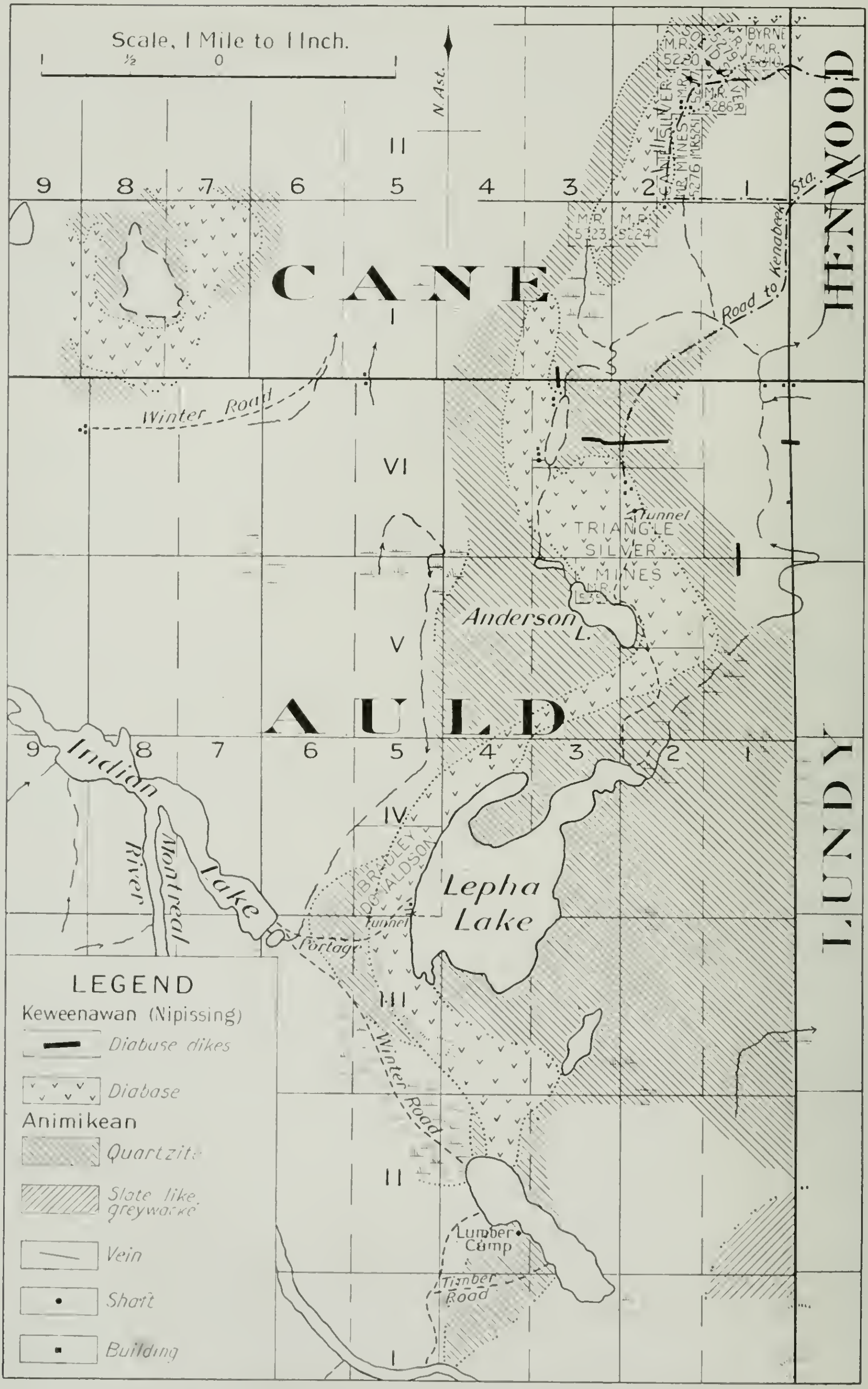
Geology

Two geological series are found in the area, namely, quartzite together with some slate-like greywacké of the Animikie age, and quartz-diabase of Nipissing (Keweenawan) age.

Animikie—The Animikie consists chiefly of quartzite, which is found so abundantly in the Montreal river district. It resembles the quartzite known as the Lorrain quartzite near lake Timiskaming, at Maple mountain and elsewhere. These rocks occur in thick beds usually with low dip. They are of greyish, greenish and reddish colour, and sometimes show some rounded quartz pebbles.

A small quantity of slate-like greywacké occurs in the southeast part of Auld, near the Montreal river.

Nipissing Diabase.—The quartzite is intruded by sill diabase which for the greater part occurs as a long, narrow ridge with a general north and south strike. Several contacts were observed in the field, which indicated that the diabase rises toward the west and dips under the quartzite toward the east. Several contacts were observed on the northeast quarter of the north half of lot 3 in the first concession of Cane, showing the upper contact of the sill, and with dip varying from horizontal to 45



Geological sketch map of parts of the townships of Cane and Auld.

degs. S.E. Other hanging-wall contacts were found to the southeast of the small lake in the north half of lot 3 in the sixth concession of Auld. Footwall contacts, showing the bottom of the sill resting on quartzite, are exposed just southeast of Anderson lake, and a quarter of a mile north of the northwest bay of Lepha lake.

An irregular area of diabase also occurs in the first concession, lot 8, of Cane, the relationship of which to the quartzite was not observed.

The diabase is mostly of the dark-grey variety, but shows in places some red phases. Occasionally some red spots of intergrown acid plagioclase and quartz are conspicuous in the dark-grey normal diabase.

Numerous dikes of red aplite, up to about two feet in width, are found here and there throughout the diabase. These dikes are frequently associated with the cobalt, nickel and silver ores. A few unimportant diabase dikes intrude the quartzite.

Veins

There are a number of veins of calcite and dikes of aplite that are silver-bearing. They occur toward the hanging-wall side, or upper part, of the diabase sill. The main outcrop of diabase is a long narrow section of a sill extending in a general north and south direction. The veins of calcite and dikes of aplite are approximately at right angles to the contact of the sill with the overlying quartzite, consequently the strike approaches east and west. A number of properties have been located on the diabase ridge, and the exploration of those along the easterly side has shown silver-bearing veins of promise.

Generally where an aplite dike is mineralized, it is accompanied by calcite and quartz veinlets, either irregularly in the dike or parallel to it. Veins in which aplite, quartz and calcite occur are more numerous than the ordinary silver-bearing calcite veins. The silver-bearing aplite dikes vary in width from an inch to 18 inches. The aplite is a differentiation from the diabase magma, sometimes occurring in dikes with well-defined walls. Again, the aplite may grade into the normal dark diabase and still have a dike-like structure, suggesting a segregation from the diabase magma in the process of cooling with consequent shrinkage, the more acid portion of the aplite being near the centre of the dike.

The quartz in the veins is later than the aplite, and the calcite the latest gangue mineral. Frequently there is a narrow band of quartz between the diabase, or aplite, and the calcite.

The smaltite usually accompanies the calcite, and native silver may occur as masses in the smaltite and calcite, or as sheets and scales in the quartz, aplite and diabase. Where veins of calcite occur in diabase or aplite, one portion may be replaced over its width with massive smaltite and silver, and thus show bunches or small shoots of high-grade along the vein, with adjacent parts containing little or no smaltite or silver.

Properties

Cane.—The Cane Silver Mines comprise three mining claims, M. R. 5277, 5251, 5276, in lot 2 in the second concession of Cane township. They are situated along the narrow ridge of diabase that extends from Auld to Cane.

A number of silver-bearing veins occur along the easterly side of the diabase ridge in proximity to the overlying quartzite, consequently they are in the upper part of the diabase sill. They are approximately at right angles to the contact, varying in strike from N. 70 degs. E. to S. 70 degs. E. Eight veins have been located and work was being done on three of them in the fall of 1920. Open cuts were made on veins Nos. 1, 2 and 8, and ore has been bagged from each of these. No. 1 was traced for 175 feet, with strike N. 70 degs. E. and dip 80 degs. N., extending westward across the boundary to the next claim. This vein is aplitic in character, showing lenses of calcite, smaltite, niccolite and silver and some bismuth, varying in width up to four inches. There are also branching veins, in one place three in a width of four feet. There is also some leaf silver in the diabase along the veins. One lens of high-grade ore that was mined was about three feet long, carrying massive smaltite studded with native silver. A sample of high-grade ore has the following partial composition: Co.—19.29; Ni.—3.67; As.—46.44 per cent.

An open-cut was made on No. 2 vein which contains two leads about two feet apart. Aplite is also the chief gangue of these veins, one showing a width of two to three inches, with streaks of high-grade silver ore about ¼-inch to ½-inch thick, and forming a rib-like structure in the aplite. At times the high-grade ore runs diagonally across aplite. These high-grade streaks carry silver, smaltite and calcite. Some leaf silver is also found in the diabase near the veins.

No. 8 vein, on the northerly claim of the group, is also of aplitic dike character with an average width, where exposed by trenching, of 14 inches. One section of the dike for 20 feet shows an abundance of cobalt bloom on the surface. An open cut was made along this section, revealing lenses and impregnations of smaltite carrying native silver. The silver-bearing smaltite occurs irregularly, sometimes along the walls of the dike, sometimes running diagonally across the dike, and again as rounded nodular-like masses in the aplite. The aplite where it contains smaltite and silver is impregnated with calcite. A shaft was sunk on this vein, using hand steel, to a depth of 40 feet, the vein maintaining its width with ore similar to that found at the surface. Work was stopped in December. It is expected that a compressor plant will be installed at a later date, when mining will be resumed.

Previous to October 1, 1920, 100 sacks of ore weighing 3½ tons and assaying 402 ounces of silver per ton, were shipped from open-cuts to the Cobalt Reduction Company. One hundred sacks in addition were taken from the open-cuts and shaft before work ceased for the winter.

J. J. Byrne is manager of the property.

Triangle.—The Triangle Silver Mines, situated in Auld township, consists of 1,000 acres, being part of lots 2 and 3 in the fifth and sixth concessions. Silver was discovered on the group in 1912, and this discovery is described by C. W. Knight (1) as follows:

> "On the Hitchcock location, south half of lot 3, Con. VI, there are a number of narrow east and west veins, in some of which native silver with some smaltite and bloom have been found. The wall rock of the veins is usually aplitic. On the westerly side of the easterly diabase ridge native silver occurs in fairly coarse dentritic form. At the northerly exposure there is coarse-grained reddish aplite which is heavily stained with bloom. The aplite has more the character of a differentiation of the diabase than a clearly defined dike. At the other exposure where silver was seen, there is a grey aplite along one perpendicular surface of which there is native silver in dendritic form.

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(1) Ont. Bur. Mines, Vol. XIX, 1913, Part 2, p. 163.

Veins were later discovered on lot 2 lying to the east and near the contact with the quartzite. The group of claims was operated first as the Kenabeek Silver Mines and later re-organized as the Triangle Silver Mines. On lot 2 a tunnel has been driven westward on a fracture on the east side of a high diabase ridge. The principal work, however, has been on a series of veins, the principal one of which strikes N. 66 degs. E. and dips 80 degs. S. A shaft has been sunk to the 132-foot level, on the dip of the vein, and to the 182-foot level at a flatter angle. Drifting and cross-cutting have been done on the two levels, most of the work being on the upper level. A faulted zone, 10 feet to 12 feet in width and dipping flatly southward, was encountered at the first level.

The calcite veins on which underground work was done carry segregations of native silver, smaltite and niccolite. The veins vary from an inch to six inches in width, while some heavy sheet silver is occasionally encountered in the wall rock. A small quantity of ore has been raised from the mine but no shipments have been made.

W. R. Hitchcock is managing director and W. H. Jeffrey is mine manager.

Shepp.—The two principal claims of the group are M. R. 5279 and M. R. 5286, lying just northeast of the Cane Silver Mines. An aplite dike 8 inches wide and dipping 80 degs. N.E. crosses the line between the two claims; two shafts have been sunk to moderate depts and some trenching done. The southerly shaft was sunk at the junction of two aplite dikes 6 inches and 8 inches in width. The material on the dump shows some massive smaltite, partly altered to cobalt bloom, together with a little native silver. The exposure here somewhat resembles that at No. 8 vein at the Cane mine. The property had not been worked recently, and the shafts were filled with water.

Bradley-Donaldson.—The Bradley-Donaldson property includes the south half of lot 5, con. IV., Auld. It is situated on the west side of Lepha lake, along the westerly shore of which is a high diabase ridge sloping steeply to the lake. No work has been done in several years, and the camp buildings are dismantled. A tunnel was run westward into the ridge on a calcite vein near the south boundary of the property, and it is stated that some native silver was obtained from the workings now filled with water. Fragments from the dump show a banded structure in the vein, which is composed chiefly of grey calcite with narrow ribbons of quartz. The structure indicates a replacement type of vein along a fracture in the diabase. In this localtiy the diabase dips steeply beneath the quartzite and the workings are near the upper contact.

End of Part III.

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Province of Ontario, Department of Mines

HON. H. MILLS, MINISTER OF MINES   THOS. W GIBSON, DEPUTY MINISTER

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OF THE

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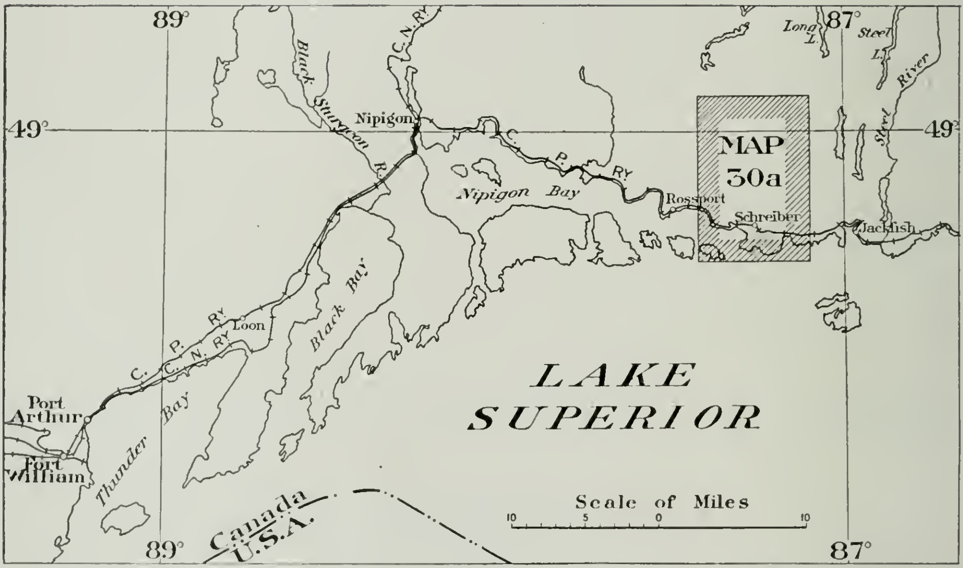
GEOLOGICALLY COLOURED MAP

No. 30a,—Schreiber-Duck Lake Area, scale 2 miles to the inch.
(*In pocket on inside of back cover.*)



Index Map showing location of area covered by the Schreiber-Duck Lake map, No. 30a.

SCHREIBER—DUCK LAKE AREA

By Percy E. Hopkins

Introduction

This report deals with the geology and economic resources of an area lying on the north central shore of Lake Superior between the Whitesand and Black rivers and northerly to Big Duck lake, embracing approximately 210 square miles. Schreiber, a divisional point on the Canadian Pacific Railway, is situated in the south central part at 48°50′ north latitude and 87°50′ west longitude, 133 miles east of Port Arthur.

Accompanying this report is a coloured geological map of the area on a scale of one mile to the inch. The water routes shown in full lines on the map were surveyed by micrometer and prismatic compass and tied to surveyed mining claims or to the railway. Townships referred to by numbers 84, 85 and 86 have been outlined on the map, but as yet are not completely surveyed. The rugged nature of the country, the difficult canoe routes, and the absence of roads tended to make the mapping difficult. The geology and topography of the area between Lynx and Birch lakes, Copper island and Rope lake were kindly furnished in advance of publication by T. L. Tanton of the Geological Survey of Canada.

A. R. Clark and C. S. Parsons acted as assistants during the season, and rendered efficient service. The accompanying sketches were drawn by P. A. Jackson and H. C. Smith. The writer wishes to express his thanks to W. L. Longworth, L. H. Estell, W. S. Jackson, J. D. Mudge, D. McQuaig, and officials of the Duck Lake Mining Company for assistance rendered in the field in various ways.

Previous Work and History

The area is included in the general geological map, No. 964 on a scale of eight miles to the inch, which accompanies W. H. Collins' report on the region lying north of Lake Superior between the Pic and Nipigon rivers.[1] In 1914 the writer made a preliminary report[2] on the Big Duck Lake Area which was accompanied by a coloured geological map on a scale of two miles to the inch.

Among the early stakings in the area were the Martin locations Nos. 1 and 2 on Schreiber peninsula, which were surveyed in 1872 before the construction of the railway. The finding of gold on Victoria cape, Jackfish bay, led to other discoveries in the area, namely the Empress in 1895, the Otisse in 1896 and the McKellar in 1898. Gold was found at Big Duck lake in 1906, but little activity was shown until spectacular showings of gold were found on the McQuaig and Sjolander-McKirdy properties in 1914. In 1919 W. S. Jackson found narrow rich gold-bearing quartz veins in the vicinity of the Otisse, three miles east of Schreiber. This resulted in many claims being staked and the re-opening of the McKellar.[3] The Zenith zinc mine, although found about 1880, did not ship ore until the years 1899 to 1901. A trial shipment of iron pyrites was made from the Morley, near Schreiber in 1897. For the last ten years cobble stones and pebbles have been picked from the Lake Superior beach near Jackfish, and shipped to cement mills for grinding purposes.

Topography

The area is practically all rock with a few small areas of sand and gravel in the vicinity of Selim, Schreiber and Blue Jay stations. The shore line of Lake Superior is on the whole rocky, frequently rising abruptly for 200 or 300 feet, as on the west side of Schreiber peninsula, thus presenting bold and striking scenery. Inland the rocky hills attain a height of 800 or 1,000 feet above Lake Superior, but the rise is often gradual. Usually the Keewatin hills are higher than those composed of granite. An ice sheet has passed over the tops of these high hills, the tops being polished and grooved and covered in places by a few feet of gravel and an occasional large erratic. Glacial rivers have apparently transported most of the material now forming the lake beaches which can be seen beautifully at Selim, Terrace bay and east of Jackfish station. The gravel beaches are not derived from the rocks 'in place'. The sand and gravel deposits on which Schreiber is located are apparently delta deposits formed from gravels brought down by glacial rivers. Blue Jay lake may have originated as a kettle lake. Certain of the beaches are followed by the railway right of way.

---

[1] Geological Survey of Canada. 1909.

[2] Ont. Bur. of Mines Report, Vol. XXIV, 1915, pp. 9-13.

[3] Now known as the McKellar-Longworth.

Vein showing the southern part of Schreiber. The town is built on what appear to be delta deposits, and is nearly surrounded by rocky ridges, 200 feet in height.

Gravel terraces or old lake beaches, about one quarter of a mile south of Schreiber.

The magnetic and astronomic north are practically identical.

Timber, Waterpower, etc.

Owing to the rugged and rocky nature of the country there is no agricultural land whatever.

On the whole the trees are small. However in a few localities as at Schreiber peninsula, Victoria lake and north of Blue Jay lake the spruce, birch and poplar have attained a size of two or three feet in diameter.

Speckled trout and brook trout are plentiful in most of the small lakes and streams near lake Superior. It is reported that no fish have ever been caught in Big Duck lake.

Gorge below 90-foot falls, Black river, near Schreiber.

An excellent small power could be developed on the Black river directly south of the railway where the river has a vertical drop of about 90 feet. Schreiber at present is furnished with electricity generated by coal. Big Duck creek as it leaves the lake by the same name drops over a fall of about 75 feet, but only about 50 or 100 horsepower could be developed owing to the small volume of water.

General Geology

The compact rocks of the area are pre-Cambrian, which have been glaciated. They may be classified according to the following table, the oldest being placed at the bottom.

	PLEISTOCENE
Glacial and Recent	Sand and gravel.
	PRE-CAMBRIAN
Keweenawan	Quartz-diabase, olivine diabase dikes and sills. Basic amygdaloidal lavas. Conglomerate, tuff, red dolomite and limestone.
Animikie	Black shale, iron formation and conglomerate.
Algoman (?)	Quartz, feldspar—and granite—porphyry, schistose in places.[1] Hornblende and biotite granite and syenite, gneissic in places.[2]
Pre-Algoman (?)	Serpentine.
Keewatin	Felsite and rhyolite with subordinate basalt areas. Iron formation. Pillow lavas altered to hornblende, chlorite, carbonate sericite schists; rhyolite, agglomerate, tuff, diorite, horneblendite and felsite. Grey garnet, mica schists [Couchiching (?)].

---

[1] The badly sheared porphyries may be of older age than Algoman.
[2] The granite gneisses near Birch and Rope lakes may be Laurentian.

Keewatin

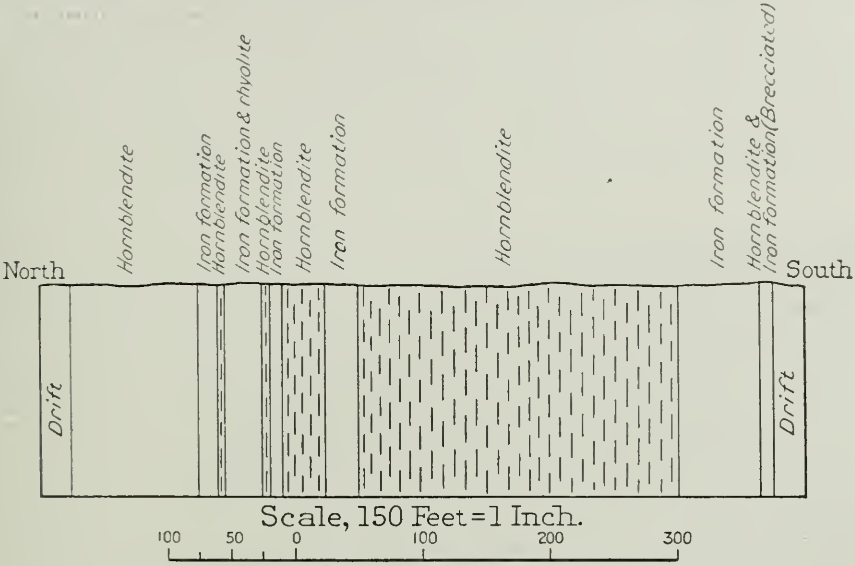
The Keewatin rocks occupy a considerable portion of the map area. In this group there are various types of rocks, and they are important since they contain most of the economic minerals.

The oldest rocks in this system are the banded grey mica schists, garnetiferous in places, which occur in the vicinity of Rope and Birch lakes. Somewhat similar rocks occur on the railway 2.4 miles west of Schreiber and on Ansel lake. They appear to be highly metamorphosed clastic rocks occurring near the periphery of the Keewatin, suggesting that they may be a basal portion of the Keewatin—probably Couchiching in age. In the vicinity of Loon lake the rusty-grey, quartzose mica schist and the Keewatin pillow lavas are intermixed and probably interbanded, over a width of a mile. The rocks are intruded by numerous pegmatite dikes.

The main portion of the Keewatin is basic pillow lava which has been highly altered to hornblende, chlorite, carbonate, sericite and other schists. Associated and interbedded with these flow rocks in places are rocks of an intermediate or acid character, felsite, tuffs, conglomerate and iron formation. Many of these rocks have been folded on end and entirely altered to secondary minerals. Pillow lava altering to serpentine can been seen on the south end of Cook lake and on claim A.L. 54. The prevailing strike of the schist is north-70°-east and the dip nearly vertical; however, in the vicinity of Schreiber the strikes vary considerably. At Victoria lake, five miles north of Schreiber, narrow bands of rhyolite, diorite, hornblende schist and iron formation are repeatedly interbanded as shown in the section. A sample of hornblende schist retaining a faint pillow structure on the McQuaig location shows under the microscope about 60 per cent. of hornblende partly altered to chlorite and replaced by quartz in a fine groundmass of quartz, sericite, calcite, chlorite, kaolin, epidote, magnetite and pyrite.

Diorite occurs in considerable volume in the vicinity of the Zenith mine and elsewhere. The rock has been separated on map No. 964 of the Geological Survey of Canada as an eruptive, and described on page 17 of the accompanying report No. 1081, by W. H. Collins as follows:—

A small area of diorite occurs on the Whitesand route, twelve miles north of Winston. The rock is fairly coarse, and rich in hornblende, sometimes approximating to an amphibolite. It contains both brown and blue-green hornblende, the latter fibrous, lime feldspar in laths, sometimes quartz, and commonly in the darker varieties masses of pyrite. The area is less than three miles across.



Section across Keewatin rocks exposed by a trench on mining claim T.B. 3575, five miles north of Schreiber.

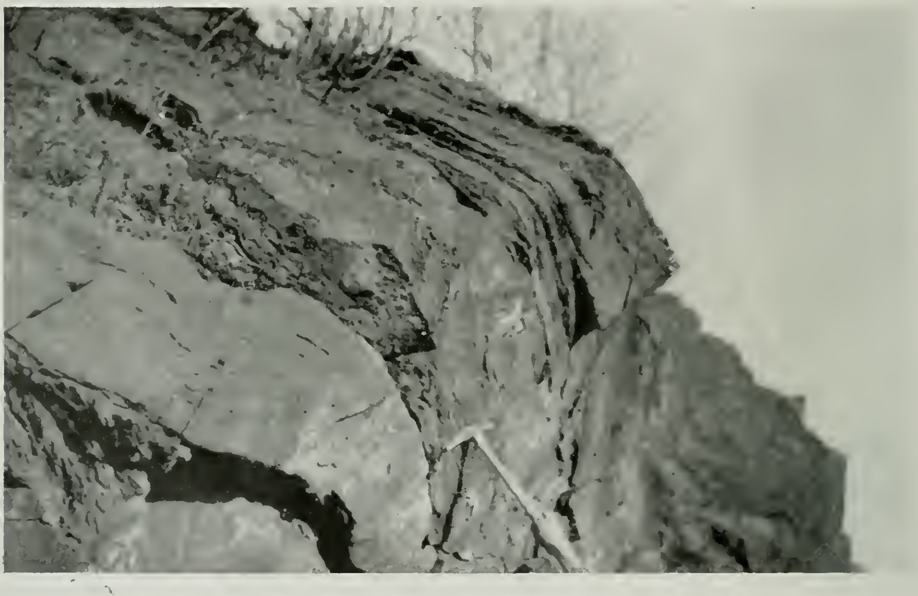
Diorite and amphibolite were found to occur in various parts of the Big Duck lake area. A coarse massive rock resembling diorite and occurring along the trail about one and one-half miles north of Louise lake, appears to be a basic phase of granite. Further north on claim T.B. 3452 the diorite becomes pegmatitic in character. In many parts of the Big Duck Lake area the diorite and hornblende schist (altered pillow lava) are so intermingled that it is almost impossible to map the diorite separately, particularly when the latter has been sheared. At Johnson lake, near the Zenith location, T. L. Tanton found the diorite to be massive close to the granite, and to be cut by pegmatite dikes.

Iron formation comprising narrow bands of chert, sugary quartz and magnetite and occasionally pyrite and pyrrhotite occur in several parts of the area. Five miles north of Schreiber a number of locations have been staked out on a long narrow band of iron formation from which low contents of gold have been obtained. Considerable prospecting for gold has been done on iron formation over various parts of the Province, but as yet has developed no appreciable quantity of ore. Narrow bands of grey limestone up to two feet in thickness with some slate and greywacké form part of the formation at Schreiber and on the railway about one mile to the southeast. These sediments at Schreiber are from six to eight chains in thickness, the strike being northwest-southeast and dip 60 deg. to the northeast. On the whole they resemble the Grenville of Eastern Ontario. Associated with the iron formation of the Morley, Jackson and Otisse claims is a graphitic schist. W. H. Collins refers to a vein of impure graphite on Rope lake. Banded cherts can be seen on the railway in the first rock-cut west of Schreiber and at a mileage 2.35 west of Schreiber.

A narrow band of conglomerate carrying obscure pebbles of chert, felsite and grey granite porphyry occurs on the railway one mile west of Schreiber.

The sediments, bounded on both sides by pillow lava, strike northwest-southeast, dip 50 deg. northeast, and in many ways resemble the Timiskaming conglomerate.

Felsite and rhyolite, pink to grey in color and apparently contemporaneous with the iron formation, outcrop in an area of three square miles directly to the south of Schreiber. Small areas of basalt have been included with the rock in mapping. About 380 yards southeast of the station, granite can be seen cutting the felsite. The rock is usually fine-grained, resembling chert in places, while elsewhere it has the texture of fine-grained granite. Under the microscope can be seen occasional feldspar and quartz phenocrysts in a fine-grained mass of the same minerals. In some places the rock is brecciated, and in others, it contains considerable disseminated iron pyrites.



Banded iron formation in a railway cut one mile east of Schreiber. The darker bands are impure limestone.

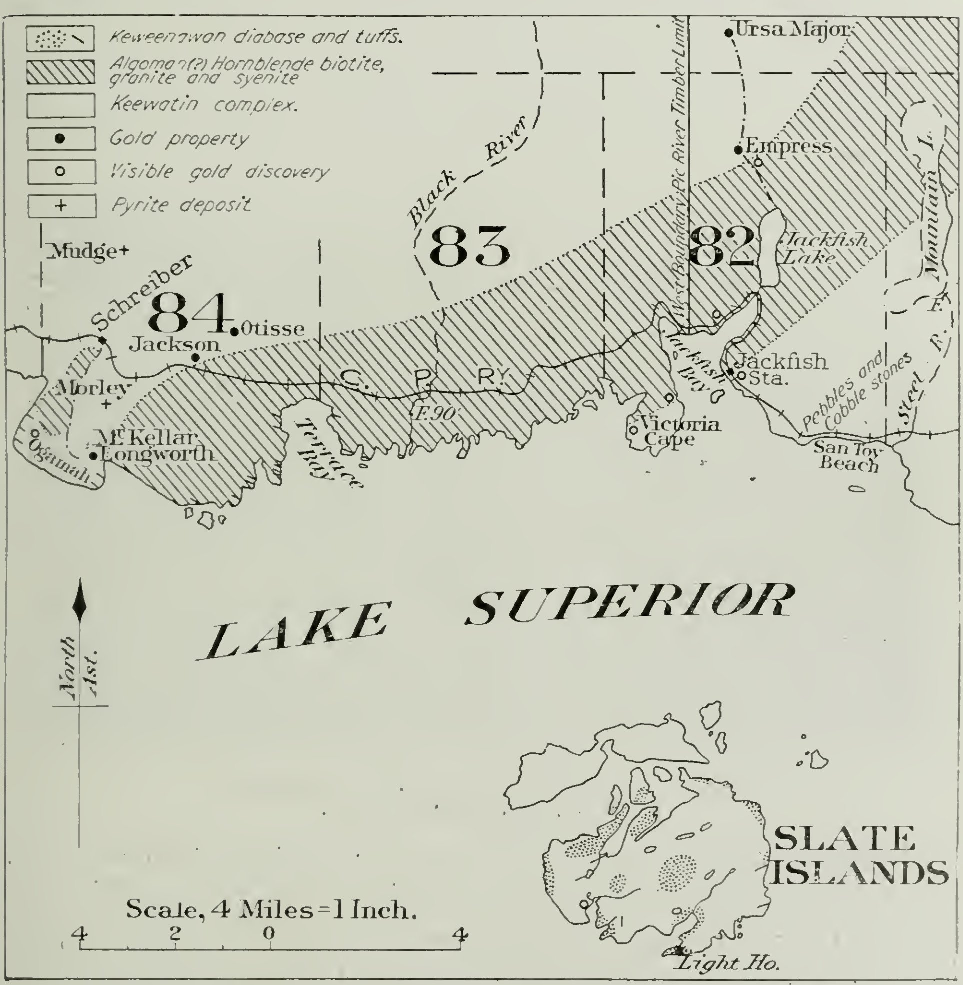
Pre-Algoman?

Serpentine.—Only one outcrop of serpentine was seen in the area, namely, on the south shore of Bear lake. It is clearly a dike, cutting typical Keewatin green schists, and is classed provisionally as pre-Algoman or Haileyburian, since it resembles in every way the pre-Algoman serpentines in many parts of north-eastern Ontario. The serpentine contains some fine-grained magnetite and minute veinlets of asbestos. Under the microscope some of the serpentine has olivine outlines suggesting that it may be altered periodite.

Algoman?

After the Keewatin was regionally metamorphosed it was intruded by large masses and dikes of granite, syenite and porphyry, which in places enclose Keewatin fragments, and in other parts underlie Animikie sediments. The granite, which is usually in sharp contact with Keewatin, is massive and fresh looking, resembling Algoman granite. A few small granite-gneiss areas, probably of Laurentian age, occur at Rope and Birch lakes, where the rocks are intimately mixed with grey mica schists. Nearly all these acid plutonic rocks are massive, pink to grey in colour, medium in grain and of the hornblende-biotite type. At Jackfish the rock is red hornblende quartz syenite containing fairly fresh microcline. In going westerly to Schreiber the syenite alternates with, and grades into, hornblende-biotite granite with feldspars showing little alteration, the accessory minerals being apatite, sphene, magnetite etc.

Extending along the northern edge of this granite-syenite mass from Jackfish bay to Schreiber peninsula, are found the chief gold deposits of the area. Gold has also been found at Victoria cape and Jackfish station, the two places where the Keewatin-granite south contact is exposed. In addition to gold, there are many other minerals occurring in veins in the granite with a northwest-southeast strike. Copper pyrites and molybdenite occur in narrow quartz veins on R 655, R 656 and R 660. Fluorite, specular hematite and chalcedony are found in quartz veins at mileage 111.6, seven miles east of Schreiber. A narrow vein of barite and fluorite assaying 2 ounces of silver per ton can be seen in a fault at the 90-foot falls near the mouth of the Black river.



Key map showing the relationship of gold deposits to a batholitic mass of granite and syenite near Schreiber and Jackfish.

The wall rock on the McKellar-Longworth west vein on B.J. 122 is a red porphyritic hornblende syenite, the analysis of which is as follows:—silica, 59.82 ferric oxide, 3.67; alumina, 16.03; lime, 4.60; magnesia, 3.04; soda, 4.50; potash, 1.26; water (combined) 2.33; carbon dioxide 0.07. Total, 100.12 per cent.

Massive, porphyritic, hornblende-biotite granite, and syenite with red orthoclase crystals one inch across occur along the railway between Selim and Horn siding. The rock is pink to deep red in colour, and is cut by small dikes of aplite, pegmatite and porphyry, probably differentiation phases of the granite-syenite magma. Small veins of barite were noticed in the granite near mileage 7 on the railway.

The small exposure of grey hornblende granite on T.B.3576 at Victoria lake contains an abundance of disseminated iron pyrites.

Porphyries of various kinds occur in the area, but they are most prevalent in an area of eight square miles at Big Duck lake. Here they are dominantly of the light-grey quartz porphyry type, and occur as dikes and stocks up to a third of a mile in width. They vary from the massive, slightly unaltered type to the schistose highly altered variety. The much sheared calcareous quartz porphyries may be of an older age than the massive type, but they are grouped together on the map. The presence of so much calcite, sugary quartz and pyrite gives the rock a vein-like appearance as on T.B. 2091, 2123 and 3458. An occasional reddish quartz-feldspar porphry dike can be seen on T.B. 3250, 3324 and other claims. Under thin section the quartz porphyry is seen to contain large rounded phenocrysts of quartz, some being hexagonal in outline, with an occasional microcline and biotite crystal set in a micro-crystalline ground-mass of quartz, calcite, chlorite, leucoxene, epidote and hornblende with some pyrite. The minute feldspars in the ground-mass are altered to sericite and other materials.

Thin sill of diabase cutting Animikie sediments,
Winston point, Lake Superior.

Fine-grained quartz porphyries or rhyolites, schistose in places, occur with the Keewatin between Maude and Lynx lakes.

Numerous dikes of granite, granite porphyry, feldspar porphyry, aplite, pegmatite, mica lamprophyre etc.—probably apophyses from the granite—cut the Keewatin rock in the vicinity of the Jackson gold location three miles east of Schreiber.

A quartz porphyry dike intrudes the Keewatin on the Morley claim, R. 606.

Animikie

Small erosion remnants of Animikie conglomerate, iron formation and black shale occur along the shore of Lake Superior between Winston point and Flint bay.[1] These rocks are the only known Animikie representatives on the north shore of Lake Superior east of Thunder Bay, and they may have been saved from complete erosion by a fault which extends along the shore at this place. The rocks which are cut by thin sills and dikes of diabase, have a total thickness of about 12 feet and dip from five to ten degrees to the south. The faintly altered sediments lie unconformably on the Keewatin green schists and Algoman (?) red porphyritic granite, notwithstanding the fact that the granite is in sharp contact with the iron formation and conglomerate, and that no granite pebbles occur in the latter.

The iron formation comprises banded silica and pyrite, chert, siderite and taconite. The black shale is oily in appearance, and contains thin layers and small nodules of iron pyrites. A few small veins of barite, calcite, amethyst, etc., cut the formation. On the easterly Animikie outcrop in Flint bay, a small float of pure hematite was observed.

Keweenawan

The Keweenawan comprises conglomerate, tuff, red dolomite and limestone (Nipigon sediments) conformably overlain by basic amygdaloidal lava flows, and cut by normal diabase and olivine diabase dikes and sills. The Nipigon sediments and amygdaloidal lavas in the map area occur only on Copper island, the geology of which was kindly furnished by T. L. Tanton, Geological Survey of Canada. On this island the flat-lying sediments strike 20 deg. south of east and dip 6 deg. or less south 20 deg. west. According to Mr. Tanton, small amounts of native copper occur in veinlets and amygdules in the lava on the northwest shore of the island. Diabase sills can be seen cutting the Animikie sediments on the main shore, directly north of Copper island. Normal diabase, quartz diabase and olivine diabase dikes are found cutting all the other formations in the area. The dikes appear to be most prevalent on Schreiber peninsula, where they have a constant strike of about 25° south of east, and dip vertically or plunge steeply about north 25° east. East of the map sheet between the Black river and Jackfish bay only a few diabase dikes were seen cutting the formation which is all granite and syenite, with the exception of a little Keewatin on the south end of Victoria cape, suggesting that the Keweenawan formation may not have extended this far east. A. L. Parsons, however, has mapped considerable Keweenawan diabase and tuffs on Slate island, 7 miles south of Jackson Station. Olivine diabase with a decomposed surface may be seen cutting the Keewatin pillow lava on the railway at mileage 5, west of Schreiber. A similar dike cutting the granite occurs one-half mile further west on the railway. A typical quartz diabase with beautiful ophitic texture occurs on the three-quarter mile portage on Big Duck creek. Under thin section the quartz is seen to occur in large grains and also intergrown with the plagioclase with some augite, magnetite, etc.

Glacial Deposits

Schreiber, 395 feet above Lake Superior, is on a sand and gravel delta deposit formed from material brought down by a glacial river. As Lake Warren receded, at least three beaches were formed to the south of the town, as shown in the illustration on page 2. Better preserved and more striking beaches occur at Selim, Terrace bay, and east of Jackfish. Many of the gravel terraces on the north shore of Lake Superior have been studied by A. C. Lawson.[1]

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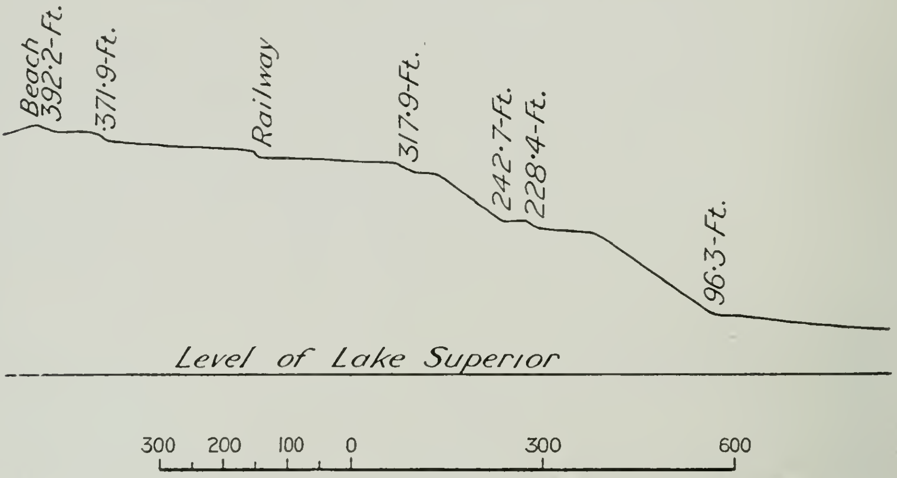
[1] Otherwise known as Collingwood bay.



Profile of sand and gravel deposits at Terrace Bay, after A. C. Lawson, 1891.

Lake terraces, Terrace Bay, north shore of Lake Superior. From Agassiz's "Lake Superior." These gravel terraces are now covered by large trees. See Ontario Bureau of Mines Report, Vol. 7, p. 204.

A pebble of Nipigon red dolomite was seen in the drift at Big Duck lake; similar pebbles were seen near the railway at Schreiber, but these may have been transported from ballast pits elsewhere.

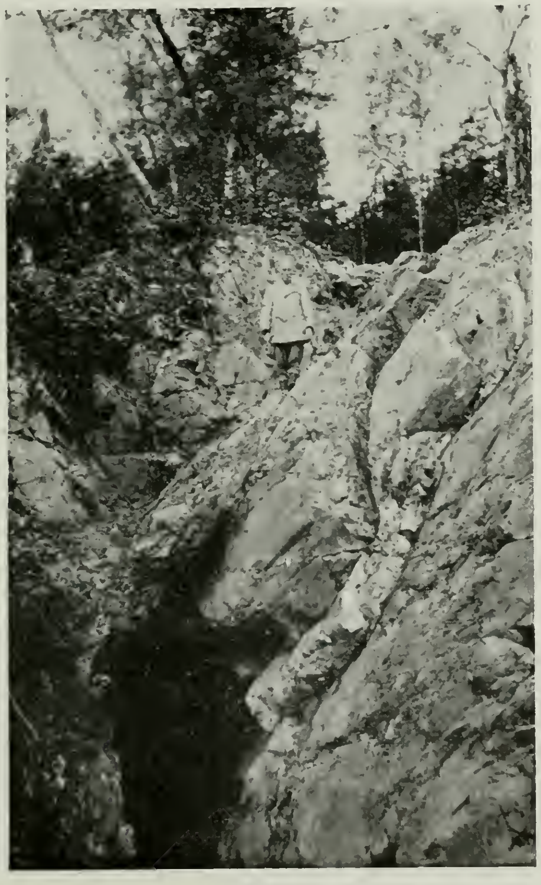
---

[1] The Geological and Natural History Survey of Minnesota, 20th annual report, 1891, pp. 183-289.

Economic Geology

The principal mineral sought for in the area is gold, which was produced at the Empress mine near Jackfish between 1896 and 1899. Small shipments of gold ore for test purposes have been made from the McKellar-Longworth, Otisse and Jackson properties near Schreiber, and from the McQuaig and Sjolander-McKirdy at Big Duck lake. During 1921 work was carried on at the McKellar-Longworth and Jackson prospects.

Iron pyrites is found in encouraging quantities on the Morley claim, south of Schreiber, and on the Mudge near Cook lake, but no shipments have been made apart from a car-load in 1897 from the Morley.



Tunnel on east vein, McKellar-Longworth claim (B.J. 122). The quartz on the right side of tunnel is 18 inches wide and carries considerable visible gold.

Zinc occurs as zinc blende in diorite at the Zenith zinc mine, eleven miles north of Selim station. Between 1899 and 1901, approximately 2,700 tons of ore were shipped.

Copper, occurring as chalcopyrite in quartz, can be seen in appreciable quantities at Big Duck lake; and native copper occurs in veinlets and amygdules in Keweenawan lava on the northwest shore of Copper island.

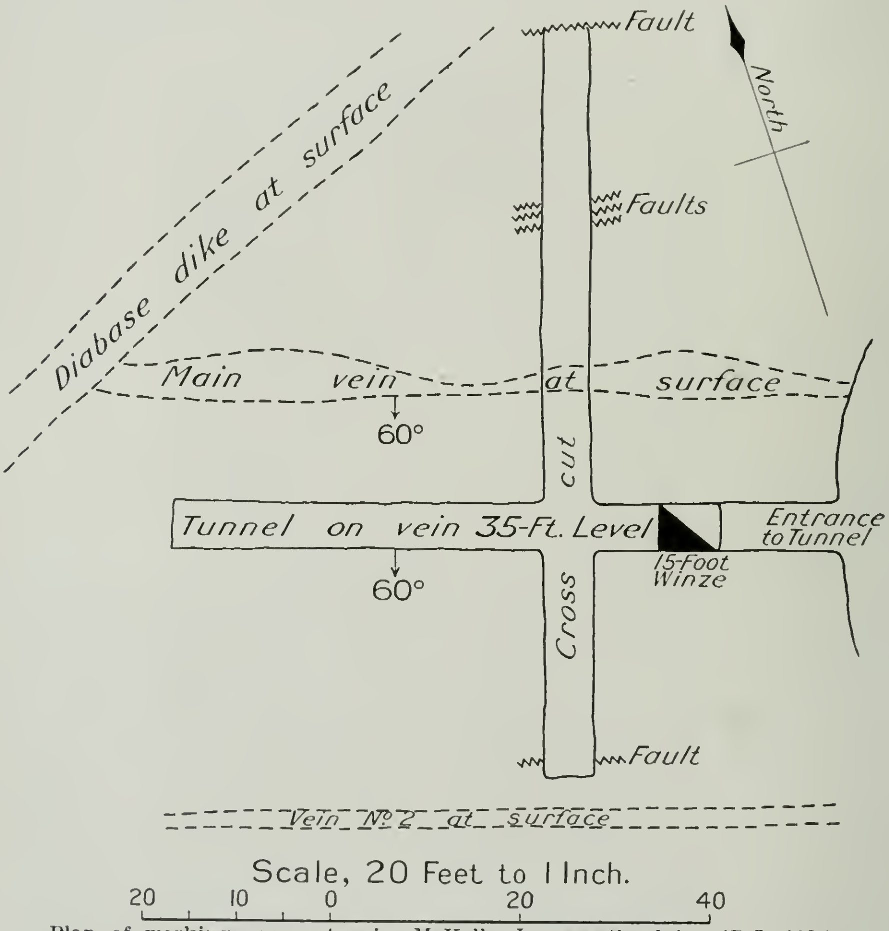
Large bodies of pyrrhotite occur in various parts of the area, but samples taken for examination showed no nickel, platinum gold or silver.

For the last ten years cobbles and pebbles have been selected from a gravel pit near Jackfish station and shipped to cement mills for use in grinding purposes.

The various deposits are described in the following paragraphs.

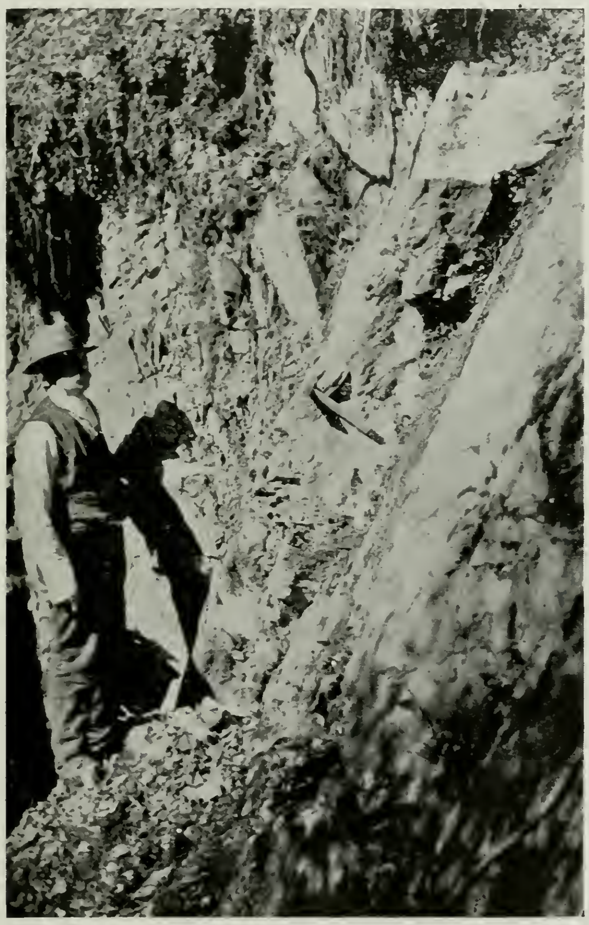
Gold Near Schreiber

There are three properties containing good showings of gold in veins in Keewatin rocks near the contact of the granite batholith.



Plan of workings on east vein, McKellar-Longworth claim (B.J. 122.)

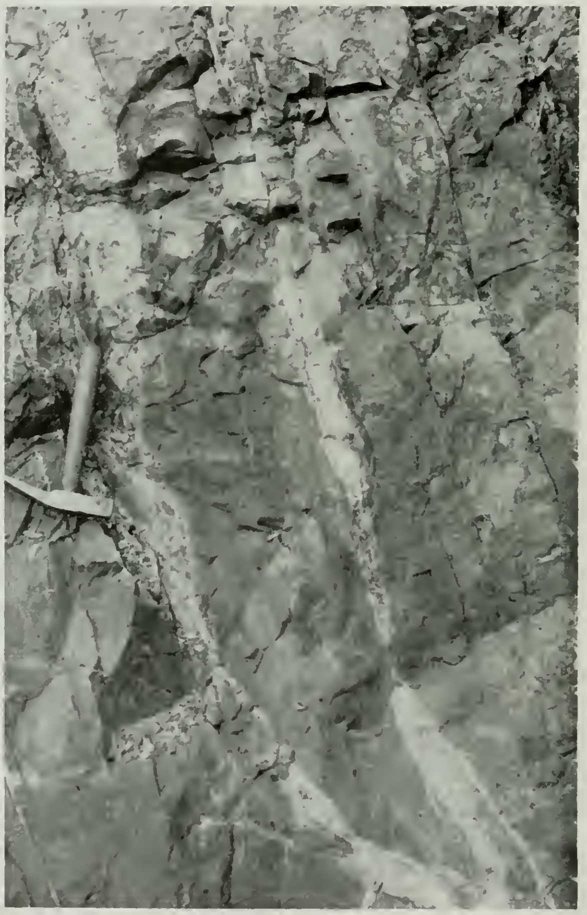
McKellar-Longworth.—The McKellar-Longworth 160-acre claim, B.J. 122, lies two and three quarter miles south of Schreiber. It was surveyed in 1898 and patented in 1903 by McKellar brothers of Fort William. The property is briefly referred to by Inspector J. A. Bow on page 89 of the tenth report of the Ontario Bureau of Mines for 1900, but owing to the claim number having been omitted and no work performed during the last twenty years, the deposit was difficult to locate. J. D. Mudge of Schreiber, assisted me by kindly drawing a sketch showing the locations of the old workings. A gold-bearing quartz vein striking approximately 10° south of east, and dipping about 55° south, can be traced for at least 200 feet. It varies in width from a foot to five feet, the wider parts comprising quartz and schist. The quartz is milky and bluish in colour and contains considerable pyrite with some copper pyrites, malachite, pyrrhotite, galena and a little fine-grained arsenopyrite. Some feldspar and calcite are also present. Considerable visible gold, some of which is quite coarse, occurs with the sulphides and a greenish talc in the fractures of the quartz. A channeled sample, across eighteen inches of quartz in which no gold could be seen, gave on assay $40.00 in gold per ton. Many specimens with visible gold were seen on the moss-covered dump.



McKellar-Longworth vein carrying considerable visible gold, B. J. 122

In the autumn of 1920 W. L. Longworth, of Port Arthur, took an option on the property and kept 10 men employed during the following year. A good camp was built and a road cut out to the property and considerable exploratory work was accomplished. A plan of the underground workings of the east vein is shown on page 12.

In the northwest part of B.J. 122 and almost in a strike with the east vein a narrow rich vein has been uncovered in hornblende syenite. The finding of a quartz float containing visible gold by L. H. Estell led to the discovery. The milky quartz is from 4 inches to one foot in width on the surface and carries considerable coarse gold in association with a grey telluride which has not yet been definitely identified. At a depth of 25 feet Mr. Longworth reports that the vein is two feet wide and carries considerable visible gold. The wall rock is a massive red porphyritic hornblende syenite. In 1921 a deposit of schist and quartz 12 feet in width was uncovered midway between the east and west veins. All three veins appear to be in one large shear zone. The results of the exploration to date are very encouraging.

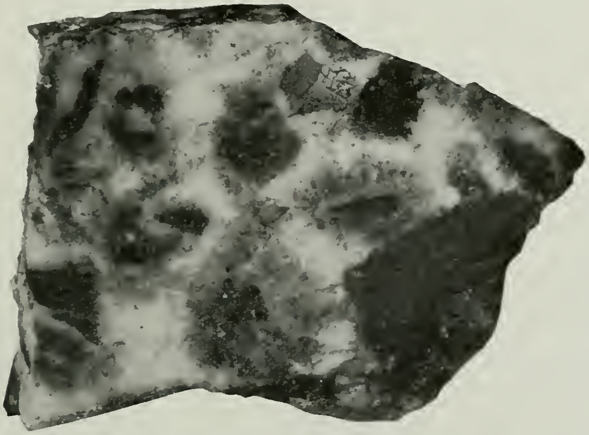


A pit on the Jackson claim, T. B. 3326, showing branches and lenses of gold-bearing quartz.

The rocks on the property are largely Keewatin chorite schist and felsite, and Algoman hornblende syenite and porphyry.

Mr. Mudge stated that in or about the year 1900 an Indian named Ogama found gold about one and one-quarter miles northwest of the McKellar-Longworth.

Jackson.—The Jackson-Hartness claims (T.B. 3327 and T.B. 3354) and the Jackson-Russel claims (T.B. 3326, etc.) are grouped under this one head. Claims T.B. 3326 and 3354, on which the richest showings are found, are restaked portions of two abandoned surveyed claims, 500 x and R. 425, which are situated three miles east of Schreiber and directly north of the railway. The obtaining of a high assay from a piece of quartz float led to the discovery of several narrow parallel gold-bearing veins two of which contain rich showings of gold. The veins strike N.E.-S.W. and dip 80° northwest along the edge of a large hill of Keewatin lavas, diorite, iron formation, etc. At the base of the 200-foot hill is Algoman hornblende granite and syenite which extends four miles southerly to Lake Superior. Dikes and sills of granite with differentiation facies, namely, porphyry, hornblende syenite, mica, lamprophyre, aplite, etc., penetrate the Keewatin for several hundred yards from the contact. The veins cut these rocks and occasionally lie in the contact; however, two narrow diabase dikes of Keweenawan age intrude the veins.



Polished sample (natural size) of high grade gold ore from Jackson claim, T. B. 3354. The large dark crystal in the lower right hand corner is pyrite containing numerous veinlets of native gold.

The veins are 600 or more feet in length, average a few inches in width and are frequently spaced 10 feet or more from one another. The quartz in places widens to 1½ or two feet or splits up into several veinlets across a width of 5 or 6 feet.

The vein material is quartz and pyrite carrying in places small amounts of galena, zinc blende and copper pyrites, and a very little molybdenite. The pyrite frequently occurs as large cubes, an inch across, carrying visible gold. Calcite and small angular inclusions of green schist are also present—giving a brecciated appearance. One of the larger veins contains considerable dolomite. The richest ore comes from two veins, 25 feet apart and near the line between T. B. 3354 and T.B. 3326 and on either side of a narrow diabase dike.

At a point about one chain west of where one of these veins crosses the east line of T.B. 3354, the vein is 1½ feet wide and will assay about $100.00 in gold and 3 ounces in silver per ton. At this place a pit has been put down on the vein from which one ton of ore was bagged and shipped to the School of Mines, Kingston, Ontario for a stamp-mill run and a laboratory cyanide test.—G. J. MacKay, Professor of Metallurgy reported as follows:—

Value per ton 5.61 ounces ($115.90) of gold and 3.21 ounces of silver. By stamp mill and amalgamation 61.9 per cent. was extracted as bullion, 24.4 per cent. was recovered in the concentrate and 13.7 per cent. was left in the tailings. Both the concentrates and the tailings cyanide readily.

Similar high-grade material was obtained from a pit about 50 feet farther down the hillside.

Further east on these two veins and on the west side of T.B. 3326 a 30-foot tunnel has been driven into the hilside, exposing excellent showings of gold, one of the veins being 2 feet in width at this point. The deposits are worthy of further prospecting which may be done advantageously by means of tunnels, shafts and drifts.

Mr. Jackson reports that the sand and clay in the flat directly below the veins will pan well in gold.

Otisse Claim, T.B. 3412.—Gold was found on the Otisse claim, A.L. 217, four miles east of Schreiber in the fall of 1896. The claim with others adjoining was held by the Otisse Mining Company, and considerable work was done during the following year. Two shafts 1000 feet apart, were sunk 39 and 52 feet respectively, on a vein striking northeast-southwest, and dipping vertically in Keewatin basalt, rhyolite, diorite, iron formation etc. According to A. B. Willmott,[1] "the quartz vein at the northerly number one shaft is four feet wide and blue-grey in colour, having considerable pyrite and a little visible gold. The southerly pit number two, has two and a half feet of quartz and contains a little pyrrhotite. A mill test of one ton made at Kingston gave $15.53 as the value of the free gold and concentrates. A sample taken for assay gave $15.00 per ton at the School of Science." The deposits resemble altered iron formation well mineralized with pyrite and cut by secondary veinlets. A little graphite and galena were noticed in the quartz. A grey quartz feldspar porphyry dike lies directly east of the north shaft. No mining has been done in the last twenty years, but the claim has recently been restaked by W. S. Jackson as location number T.B. 3412. The old workings are referred to by Inspector J. A. Bow.[2]

The south shaft on the Otisse gold mine, as it appeared in 1898.

Gold Near Jackfish Bay

The granite-syenite batholith, near the north edge of which are the McKellar-Longworth, Jackson and Otisse gold properties in the vicinity of Schreiber, extends easterly for thirteen miles to Jackfish Bay, where gold is also found under somewhat similar conditions. At the latter place, the Empress, which produced gold in 1896-1899, the Ursa Major and other properties occur in the green schists near the granite as at Schreiber. Gold has also been found where the green schist is exposed on the southern edge of the granite batholith, namely at Victoria cape and at Jackfish station and 7 miles further south on Slate islands. Ben Almis is also reported to have discovered gold at Bottle point, 6 miles east of Jackfish. The first noted gold discovery described on the north shore of Lake Superior was found on Victoria cape. The Slate Island gold deposits are described by A. L. Parsons.[1]

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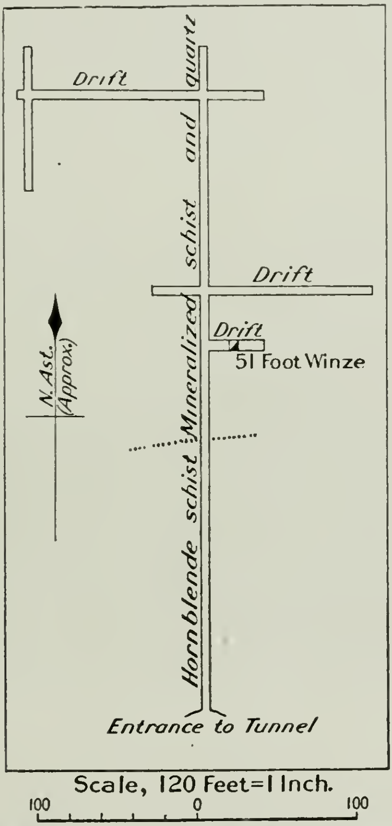
[1] Ont. Bur. Min. Report, 1898, Vol. VII, p. 134.

[2] Ibid, p. 80.



Plan of underground workings of the Empress gold mine. At the bottom of the 51-ft. winze is a drift 100 ft. in length.

Gold also occurs in the granite batholith, *e.g.* on the road at a point about one half mile southeast of the Empress mine. A. P. Coleman[2] also refers to gold in the granite as follows:—"Three-quarters of a mile west of the tunnel [mileage 103 on the railway, near Jackfish bay] a small quartz vein is found in the granite. Some years ago, as Mr. McKellar reports, rich gold specimens were obtained from it; but there was not enough quartz to justify mining it." The Empress and Ursa Major are briefly described in the following paragraphs.

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[1] Ont. Bur. Min. Report, Vol. XXVII, 1918, Part 1, pp, 155-167.

[2] Ibid, Vol. V, 1900, p. 84.

Empress Gold Mine:—The Empress Mine, R569, was discovered in June 1895 by an Indian who brought specimens to D. McKellar of Fort William. The property lies four miles from the railway and two and a half miles inland from the north end of Jackfish Bay. The gold deposits are near the northern side of a batholith of Algoman (?) granite and syenite and situated in Keewatin hornblende, chlorite, talc, and sericite schists which still retain faint pillow structure. They comprise numerous lenses of quartz up to eight feet in width on the southern slope of a large hill, striking east-northeast and west-southwest and dipping 60° to the south. There are five quartz schist bedded veins in a width of 400 feet, the northerly vein being the richest. The quartz contains much pyrite, some calcite, chalcopyrite, zinc blende, galena and a little native copper, but little visible gold, although some rich showings were said to have been found. The pyrite is more abundant in the schist than in the quartz. According to A. P. Coleman,[1] "Assays of four samples of the ore ranged from $1.00 to $4.00, averaging $2.50 per ton. The concentrates containing a good deal of sand, yielded $6.00 per ton." The veins have been cross-cut by a tunnel 417 feet in length and some drifting and stoping has been done. A 51-foot winze was sunk on the southerly vein, at the bottom of which a 100-foot drift was run. In addition, the veins have been trenched and exploited by means of shallow pits. An amalgamation and concentrating 10-stamp mill was erected in 1896, which treated thirty tons daily when operating. Seventy-five per cent of the gold was free-milling. The mouth of the tunnel is high enough to run the ore by gravity to the top of the mill, thus affording cheap mining and milling. The prospect has remained closed since December 20th, 1899. References to the property may be found in the following Ontario Bureau of Mines Reports.[2]

Mill of Empress Gold Mine.

Several locations were taken up on extensions of the Empress vein, the *Gaddes* on the east and the *Macon* on the west. Further south in the granite is the *Megatherium* property which has a small white quartz vein carrying a little pyrite, chalcopyrite and galena which show the presence of gold on assay.

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[1] Ont. Bur. Min. Report, Vol. VII, 1897, p. 135.

[2] Vol. V, 1895, p. 84, 85, 104, 189; Vol. VI. 1896, p. 56, 111, 263; Vol. VII, 1898, p. 81, 135; Vol. IX, 1900, p. 82; Vol. X, 1901, p. 87.

Ursa Major.—The Ursa Major (A.L. 219, 220) is situated on a government wagon road, three miles north of the Empress. Work commenced in August 1898 and ceased in 1900. According to Inspector J. A. Bow [1] the work consists of a shaft 121 feet deep with a cross-cut 88 feet north at the 118-foot level. The dump is schist mineralized with much pyrite. About 400 feet northeast of the shaft is a large quartz vein six to twenty feet in width, and striking a hundred and ten degrees for several hundred feet. The quartz is glassy and contains considerable iron and copper pyrites and galena, yielding on assay low values in gold. The wall rocks are green chlorite and mica schists striking northwest-southeast and cut by an occasional acid dike. The property is briefly referred to in the following departmental reports.[2]

Other properties in the vicinity are the *Jackes* (R686), *Polaris* (M23) and *McQuaig* (R692).

The area in the vicinity of this granite-schist contact extending all the way from Schreiber to Jackfish bay should be worthy of careful prospecting for gold deposits.

Big Duck Lake, looking northeast.

Slate Islands.—Rich specimens of gold have been found on various parts of Slate islands, seven miles south of Jackfish station, but according to A. L. Parsons the deposits are not promising. The richest deposit, the location of which is indicated on the map on page 7, is described by Mr. Parsons[3] as follows:—

> On the west side of St. Mary's bay is a vein with a width varying from 4 inches to 8 inches. In this vein visible gold was found, and samples the entire width of the vein were taken for assay. It is believed that these samples represent the maximum value that can be expected from any quantity of ore that might be mined from this vein. Selected samples might be taken which would yield much greater values The quartz is white and milky and the length as shown by numerous test pits is not less than 400 feet. Three samples were taken for assay, yielding $15.40, $0.00 and $3.20 per ton.

Gold at Big Duck Lake

Big Duck Lake lies 14 miles due north of Schreiber, and can be reached from the latter place by a rough winter road or by the Big Duck Creek water route in which there are 6 miles of portages. An easier canoe route is by way of Whitesand, Lynx and Charlotte lakes from Selim station.

Gold was found to the northwest of Big Duck lake in 1906 by a trapper, Joe Fisher. One claim was sold to D. McQuaig of Schreiber in 1913 and the other to C. Sjolander and W. McKirdy of Nipigon in 1914. The rich gold showings which came from these two claims resulted in many claims being staked there during 1914; however, visible gold was only reported to have been found on one other property, namely the Estell claim or T.B. 1909. Low assays can be obtained from a number of deposits and gold can be panned freely from a decomposed pyrite-calcite vein on the Longworth claim T.B. 3250. Numerous shallow pits have been sunk in an area four miles in length extending from the west end of Little Duck lake to the east end of Big Duck lake and two miles in width. The porphyry intrusions are also confined mainly to this area. Much rock is exposed and the country is easy to prospect. On the drift-covered portions the soil is distributed fairly evenly, having an average thickness of two or three feet. Apart from the Longworth and a few other claims only a little trenching has been done. Approximately 75 claims have been surveyed.

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[1] Ont. Bur. Min. Report, Vol. X, 1901, p. 85.

[2] Ibid., Vol. VIII, 1899, p. 95; Vol. IX, 1900, p. 83.

[3] Ibid., Vol. XXVII, 1918, part 1, p. 166.

The rocks are largely pillow lavas altered to hornblende, chlorite, biotite and carbonate schists striking east and west and dipping from the vertical to sixty degrees to the north. There are also massive diorites and hornblendites, some of which may be younger than the Keewatin. These are intruded by stocks and dikes of quartz porphyry up to one third of a mile in width, and by an occasional red feldspar porphyry dike, Algoman? in age. The highly sheared quartz porphyries may be of Keewatin age. The gold deposits occur in the rocks of both ages and are cut by Keweenawan diabase dikes.

The gold-bearing veins occur as lenses in the hornblende schist near the quartz porphyry, at the contact of the two rocks and in the quartz porphyry. The two principal deposits, the Beaver (McQuaig) and the Sjolander-McKirdy, are largely replacement deposits in which the gangue mineral is nearly all calcite with considerable included schist and only a few quartz veinlets. Considerable gold in a fine flour state can be seen in places; but samples taken a short distance from the gold showings usually gave low values on assay, indicating that little gold is present in the veins unless it can be seen. There are also a few large veins of the granular sugary quartz type which carry gold in small quantity. The gold appears to be genetically connected with the porphyry. The veins should be extensively trenched and sampled with the hope of locating isolated ore shoots.

McQuaig or *Beaver* (T.B. 1686).—The McQuaig deposit is largely calcite occurring in a narrow quartz poryphyry schist dike which intrudes Keewatin hornblende schist. The vein strikes east and west for 250 feet, and dips 70 degrees to the north. At the shaft there are 40 inches of calcite with an additional three feet of porphpry schist, replaced by carbonate and cut by calcite stringers on the hanging wall. An occasional quartz stringer cuts across the deposit. Both the vein and porphyry appear to end at a point about 150 feet west of the shaft. In the calcite are pyrite, coarse zinc blende, fine galena, some chalcopyrite, biotite and talc, the pyrite being altered in places to limonite. At a depth of six feet considerable gold in a fine flour state could be seen over a width of 10 inches near the centre of the foot wall section of the vein. In 1915, a small open cut was made and a 40-foot shaft sunk from which 2710 pounds of ore were sorted and shipped to a smelter yielding 2.0 ounces of gold and 3.9 ounces of silver per ton, total value $43.00 per ton. Visible gold was reported to occur at frequent intervals to the bottom of the shaft, where the vein was said to be about four feet wide.

Sjolander-McKirdy (T.B. 1861, 1955).—The Sjolander-McKirdy deposit, which lies 70 chains to the northeast of the McQuaig is in a hornblende schist which retains faint pillow structures and is distant about 800 feet to the north of a large quartz porphyry outcrop. The deposit strikes south-70°-west and dips 75° to the north, coinciding with the strike and dip of the country rocks. The vein has not been traced continuously for any great distance. Near the east part of T.B. 1861 an open cut eight feet deep has been blasted for 24 feet across the entire width of the deposit. Assays of channel samples taken in sections across this open cut indicate favourable values in gold across seven feet near the hanging wall part. Considerable gold in a state of fine division occurs about five feet from the hanging wall. Much pyrite, some galena, zinc blende and chalcopyrite are disseminated throughout the calcite-quartz-schist vein. A thin section of the gold-bearing material shows interlocking quartz and calcite grains with gold and pyrite, closely associated, lying between the grains. In the early part of 1915, 500 pounds of the vein matter were shipped to a smelter. A vein on the east claim, T.B. 1955 contains molybendite.

A vertical face of the Sjolander-McKirdy gold deposit consisting of hornblende schist, calcite quartz, various sulphide, visible gold, etc. on claim T.B. 1955, Big Duck Lake.

Other Gold Deposits.—Other deposits which resemble the Sjolander and which occur in the same approximate strike are the *Fisher* (T.B. 1862), *Estell* (T.B. 1909) and the *Madson* (T.B. 2103). On the Fisher a diabase dike intrudes the vein. The Estell deposit comprises eight feet of dark and light coloured carbonate schists carrying pyrites and cut by veinlets of quartz up to five inches in width. The owner reported he had found coarse gold in the vein. A sample across five feet of the Madson vein yielded on assay $2.50 per ton in gold and nothing in silver. This vein consists of banded calcite, pyrite, sugary and glassy quartz.

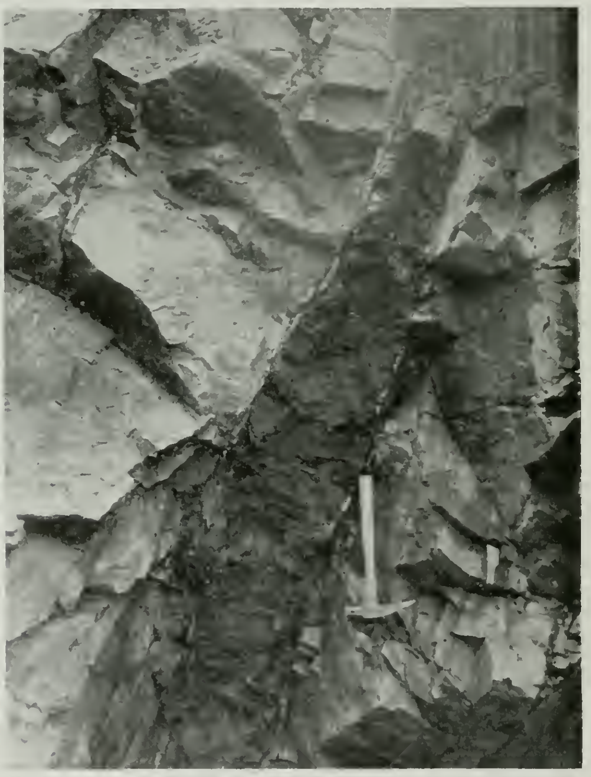
Gold can also be panned from the *Longworth* "mud" vein on claim T.B. 3250. The circuitous vein which strikes northeast-southwest for 200 feet and dips from 60° to 80° southeast occurs in hornblende schist, and altered basic pillow lava. The vein is from one to three feet wide and consists of brown and yellow soft iron oxide carrying fragments of mica, calcite, pyrite and some galena and quartz. At depth the decomposed material will probably give way to calcite and pyrite, etc. Similar decomposed material was noticed in the McQuaig, Fisher and other deposits.

A somewhat different type of deposit, namely large lenses of granular or sugary quartz up to thirty feet in width with disseminated iron and copper pyrites and some galena and feldpar, occurs on the following claims: *Duck Lake Co.* (T.B. 3184, 3304), *St. Louis* (T.B. 3353) and *Cooper* (T.B. 3382). These veins are indicated on the map. Samples from portions of them give low values in gold on assaying.

According to W. H. Collins[1] "a small gold nugget belonging to Mr. Dampier of Rossport, is said by him to have been taken from a quartz vein on Hornblende lake."

Copper at Big Duck Lake and Elsewhere

Estell Copper Claims (T.B. 1911, 3144, 3145).—These claims which are situated on the south shore of Big Duck lake, are owned by L. H. Estell of Schreiber. By means of several trenches a quartz vein some 12 or 15 feet in width has been traced for one-half mile across portions of the three claims. The vein strikes nearly east and west, and dips about seventy degrees north in hornblende schist. The vein consists of faintly banded sugary quartz cut in places by veinlets of glassy quartz, and carrying iron and copper pyrites, copper carbonates and a little molybdenite. Portions of the vein have considerable copper present and two samples assayed 40 cents in gold per ton. A similar vein carring a little calcite lies a little to the south on claim T.B. 1911.



The Longworth "mud vein" comprising limonite, calcite, pyrite and mica, from which gold can be panned. T.B. 3250, Big Duck Lake.

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[1] Geo. Sur. Canada, 1909, Report 1081, p. 21.

Burstrom Copper Claim T.B. 2091).—On this claim, which is situated one quarter of a mile west of Big Duck lake, is a lenticular copper-bearing granular quartz deposit some 20 feet by 75 feet in size at the contact of the hornblende schist and quartz porphyry, and cut by a Keweenawan diabase dike. An open cut 22 feet long and a shaft 25 feet deep has exposed a width of about seven feet near the centre of the deposit which will assay approximately four per cent. in copper. The deposit contains disseminated iron and copper pyrites, some hornblende schist and will yield on assay 20 cents in gold per ton.

A little disseminated copper pyrites and magnetite occur in a 3-foot vein of pyrrhotite on T.B. 3452, one mile southwest of Big Duck Lake.

Considerable chalcopyrite occurs in narrow quartz veins with molybdenite and other minerals on the *McKenzie* claim (R. 660) southeast of Schreiber, and in the *Blanchford* vein about three-quarters of a mile to the northeast of the McKenzie. Both these veins are in red horndlende granite and syenite. W. S. Jackson discovered small pockets of copper pyrites in Keewatin green schist on the east shore of *Ellis lake.* According to T. L. Tanton small amounts of native copper occur in veinlets and amygdules in the Keweenawan lavas on the northwest shore of *Copper island.*

Pyrrhotite on Nickel Lake and Elsewhere

In the autumn of 1914, large deposits of massive pyrrhotite and quartz and disseminated pyrrhotite were examined on Nickel lake which lies north of Big Duck lake at the extreme north end of the map sheet. Considerable work has been done on these deposits, which occur in granite-gneiss and grey schist, probably of Laurentian or Couchiching age. Moiled samples across three of these deposits yielded on assay, gold none, silver none, nickel none, platinum none. A moiled sample across five feet of pyrrhotite on the Henry Davis claim one mile east of Nickel lake, gave an assay: gold none, silver none, platinum none, and nickel trace.

Other pyrrhotite deposits were seen on the following claims:—T.B. 1894, T.B. 3452, R. 606 (Morley), E. 203, R. 658 and T.B. 3412 (Otisse). Large deposits are also reported by Jake A. Davidson to occur on the east side of Ducett lake, eight miles northeast of Schreiber. Pyrrhotite alone is of no economic value. However if large masses can be found associated with serpentine or some other basic rocks like norite or diabase, one should always look for some of the following minerals associated with the pyrrhotite:—nickel, copper platinum, gold or silver.

Zinc

Zenith Mine.—The Zenith mine (30 T) is situated about 11 miles north of Selim station, and four miles southwest of Big Duck lake. The property was discovered and taken up by the McKellar Brothers of Fort William about 1880, but remained dormant until 1899. Between 1899 and 1901 approximately 2,700 tons of zincblende were mined and hauled in winter to the railway for shipment. Much zinc still remains on the dump. According to Inspector W. E. H. Carter[1] the zinc blende occurs in small lenses which strike north and south and dip about twenty-five degrees east into a hill of trap [diorite]. The largest lens is twenty feet by fifteen feet. The property has been idle since 1901. W. L. Uglow[2] has given a summary report on the mine.

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[1] Ontario Bureau of Mines Report, Vol. X, 1900, p. 110.

[2] Ibid., Vol. XXV, 1916, Part 2, pp. 7 and 8.

Gesic.—The Gesic (E.S. 79) is a small prospect situated about two miles south of the Zenith on the road to the railway. The vein on which a 23-foot shaft was sunk in 1900 is said to strike east and west, and dips 55° north. It contains zinc blende in promising quantities.[1]

Zinc blende occurs in small quantities in many veins in the area namely:—McQuaig, Sjolander-McKirdy, northeast shore of Little Duck lake and on the Jackson.

Part of the Zenith mine workings, showing where numerous zinc blende pockets have been worked from the hill side.

Iron Pyrites

Morley.—The Morley pyrite prospect, R. 606, lies one and one-half miles southeast of Schreiber station, and one and one-half miles north of Lake Superior. A prospector named Morley sold the claim in the spring of 1897 to the Davis Sulphur Ore Company of New York, who did considerable work during the year and made a trial shipment which gave good satisfaction. The deposit consists of pyrite and pyrrhotite in a Keewatin pinkish felsite, near which is Keewatin iron formation, and a dike of Algoman quartz porphyry, all of which have been cut by a Keweenawan diabase dike. To the south of the diabase dike pits have been sunk on sugary iron formation, but no solid iron pyrites was encountered. The main deposit strikes a little west of north and dips about 65° to the east. A trench reveals a lens of pure iron pyrites about fifty feet long and three feet wide, with a similar sized lens of pyrrhotite adjoining it on the west or foot-wall side. The pyrrhotite contains a little pyrite and chalcopyrite. Twenty-five feet to the east and further down the hill-side, a shaft, now filled with water, has been sunk on a parallel lens. At the bottom of the hill a short tunnel has been driven into felsite containing disseminated pyrrhotite. A little further northeast on a creek bank a pit has been put down on graphitic schist. About 200 tons of pyrite of good grade is piled in one dump and considerable pyrrhotite occurs in other parts of the dumps. The property is referred to by J. A. Bow, A. B. Willmott and E. L. Fraleck respectively in certain reports of the Ontario of Mines.[1]

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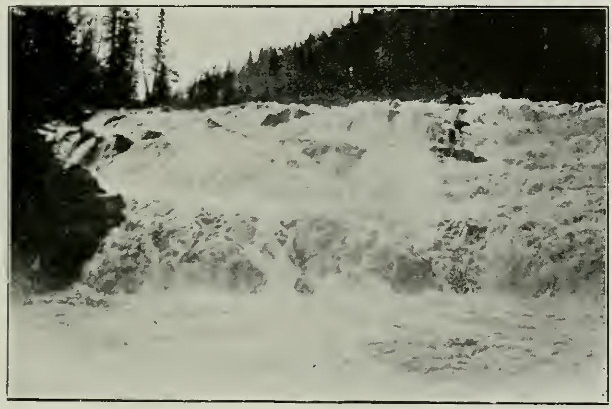
[1] Ont. Bur. Mines Report, Vol. IX, 1900, p. 87, by Inspector J. A. Bow.

Mudge.—The Mudge claim, T.B. 1048, on the northeast end of Cook lake and one mile north of Schreiber, was formerly a portion of the Otisse pyrite claim 776 X, referred to by E. L. Fraleck on page 177 of his report as follows.[2]

> A heavy fahlband strikes east and west for about a mile. The gossan capping had in several places been removed and test pits sunk. The largest of these was about 12 feet deep and 12 feet long across the strike of the deposit, which is here seen to consist of a very fine grained mixture of pyrite, pyrrhotite and silica (banded). An average sample of the dump yielded 32.26 per cent. of sulphur.

The pyrite formation gives way in places along the strike to iron formation, banded magnetite and quartz, on either side of which is Keewatin pillow lava impregnated with calcite.



Falls on Steel river at the outlet of Mountain lake. *See* Volume 9, Ontario Bureau of Mines Report, p. 112.

Running northeasterly across Sulphur lake, as shown on the map, is a banded deposit, some 2 miles in length, of sugary quartz and pyrite. Veins of pyrite up to two feet in width and carrying low values in gold were noticed, but these are too small to mine for the sulphur contents. Narrow pyrrhotite veins are also present.

Argentiferous Galena

In 1921, Mr. Darling, of Schreiber, located an argentiferous galena vein on the railway 1½ miles to the west of Middleton station, or approximately 30 miles east of Schreiber. According to J. G. Cross, of Port Arthur, the galena vein in 2 inches in thickness and contains a little native silver. It occurs in a Keweenawan diabase dike about 200 feet in width.

Pebbles and Cobble Stones near Jackfish

At San Toy beach on the north shore of Lake Superior, three miles east of Jackfish station on the Canadian Pacific Railway there is a large pebble beach and gravel pit in which occur rounded cobbles and pebbles suitable for use in grinding in cement mills. During the years 1911-1915, Mr. Whalen of

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[1] Vol. VII, 1898, Part 1, pp. 78, 80; Idem., Part 2. p. 134; Vol. XVI, 1907, p. 177.

[2] Iron Pyrites in Ontario, Ont. Bur. Mines Report, Vol. XVI, 1907, p. 177.

Port Arthur used a steam shovel and had several men bagging these pebbles along the shore and from points about 100 feet inland. The pebbles were shipped in boats to points on the Great Lakes.

Operations ceased in 1915 after considerable loss had been encountered in loading, owing to the lack of harbour facilities. One of the employees, C. W. Todesco of Jackfish, Ontario, obtained permission from the Canadian Pacific Railway Company to select pebbles from the adjoining gravel pit at San Toy siding. During the summer seasons about eighty tons a month of one, two and three-inch pebbles were shipped to the Canada Cement Company at Montreal and Winnipeg, bringing about $10.00 a ton. Some of the three-inch and four-inch cobbles would be suitable for grinding ore in the tube mills of Porcupine, Kirkland Lake, etc. The pebbles comprise granite, flint, trap, etc. Certain portions of the shore for thirty feet inland and the high banks of the Steel river directly north of the railway contain excellent unpicked pebbles.

ECONOMIC DEPOSITS IN THUNDER BAY DISTRICT

By A. L. Parsons

During the summer of 1920 the writer was engaged in the investigation of certain mineral deposits in the districts of Thunder Bay and Rainy River, paying particular attention to the iron deposits near Kaministikwia and Mokomon and the silver deposits of Silver islet and to the west of Port Arthur.

Iron Deposits

The Kaministikwia iron range is located principally in the townships of Ware and Conmee and apparently consists of the outcrops of a great synclinal fold which forms the walls of the Kaministiquia valley at this point. Magnetometric[1] and geological[2] maps of the range have been prepared by A. H. A. Robinson who shows not only the probable extent of the iron deposits, but locates the outcrops of ore, greenstone, and other rocks. Comparison with other similar deposits would seem to place these deposits in the Keewatin formation as they are intimately associated with greenstones and pillow lava which are practically identical with rocks of this age found in other localities. There are, however, no contacts with rock of other formations, so that it is impossible to state definitely the age. The deposits consist principally of banded magnetite and jaspilyte together with some hematite. The field examination proved them to be extensive and for the most part easily worked. In the preliminary stages open quarry work would permit of extensive development. The outcrops, however, are for the most part low grade and must be beneficiated by magnetic or other concentration.

Concentration and Analysis

Samples for analysis and concentration experiments were taken from claims 8 H and 393 R, Conmee township and 333 R, Ware township. The samples were crushed and each sample divided in three parts, the first for analysis of the natural ore, the second as taken from the crusher for concentration and analysis of the products, and the third, after being ground to pass 100 mesh, for treatment like the second. The analyses of the crude ore which were made by W. K. McNeill, Provincial Assayer, follow:—

	1 (8H)	2 (393R)	3 (333R)
SiO_2	50.64	43.10	40.90
Fe_2O_3	26.37	28.54	28.41
Fe O	15.89	14.26	13.09
S.	0.16	0.12	0.19
P	Tr.	Tr.	Tr.
Fe.	30.1094	30.5308	29.6182

These analyses confirm the estimate that was made in the field of the apparent grade of the ore and are only slightly lower in iron content than the figures that had been given by one of the owners.

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[1] Map 409, Mines Branch, Dept. of Mines, Canada, 1914-15.

[2] Map 410, Mines Branch, Dept. of Mines, Canada, 1914-15.

The concentration of the ores for further analysis was kindly done by Prof. F. C. Dyer of the University of Toronto.

Sample No. 1 (8 H) when crushed to one quarter inch and put through a Wetherill magnetic separator gave four products which yielded the following results on analysis:

	(1)	(2)	(3)	(4)	loss
Amp.	.03	.05	.07	....	....
Weight, grams	164	216	118	88	26
SiO_2	35.10	40.00	45.42	55.39	....
Fe_2O_3	30.24	26.98	30.02	26.97	....
FeO	17.29	14.94	11.93	6.84	....
Fe	34.70	30.486	30.274	24.78	....

When crushed to one hundred mesh the same material gave the following results:

	(12)	(13)	loss
Weight, grams	42.1	18.2	1.9
SiO_2	32.53	63.14	....
Fe_2O_3	42.10	14.91	....
Fe O	17.76	4.68	....
Fe	43.27	14.23	....

Sample No. 2 (393 R) when crushed to one-quarter inch gave the following results:

	(5)	(6)	(7)	loss
Amp.	.03	.05	....	....
Weight, grams	323	95	125	22
SiO_2	41.28	50.60	66.12	....
Fe_2O_3	37.01	32.04	19.88	....
Fe O	14.28	11.39	6.23	....
Fe	37.01	28.27	18.76	....

When ground to 100-mesh the same material gave:

	(14)	(15)	loss
Weight, grams	44.5	22.2	1.
SiO_2	33.61	75.99	....
Fe_2O_3	43.00	9.35	....
Fe O	18.56	2.67	....
Fe	44.5	9.30	....

Sample No. 3 (333 R) when crushed to one-quarter inch:

	(8)	(9)	(10)	(11)	loss
Amp...........	.03	.05	.07	tails	....
Weight Grams..	121	194	240	430	236[1]
Corrected Weight	121	194	312	558	36
SiO_2	19.75	26.06	30.73	56.16	....
Fe_2O_3	56.27	45.14	44.85	21.61	....
Fe O	16.41	16.21	13.26	6.69	....
Fe...............	52.14	44.20	41.72	20.33	....

When ground to pass 100 mesh this sample gave:

	(16)	(17)	loss
Weight..................	24.3	51.5	2.3
SiO_2	15.71	49.86	....
Fe_2O_3	51.71	25.92	....
Fe O	25.00	5.49	....
Fe......................	55.49	21.95	....

Further sampling may yield material which will give better results, though sample No. 3 gives a concentrate which is merchantable both from the quarter-inch and the hundred mesh. Combining the results from the coarser material in analyses 8, 9 and 10, we get a concentrate running 44.5 per cent. Fe on 51.4 per cent. of the ore. Finer grinding of numbers 9 and 10 would undoubtedly raise the percentage and it is probable that screening the concentrates would materially improve the product. In order to get a high grade concentrate it will probably be necessary to grind the ore to two hundred mesh.

Economic Possibilities

In estimating the value of the Kaministkwia range, comparison must be made with the other large ore reserves, not only of the Lake Superior region, but of other parts of the world. The natural ore, while low grade, may become when beneficiated, an important factor in the future development of the iron industry of Ontario. Under present conditions it is doubtful whether the crude ore would find a market under any conditions and without extremely fine grinding it would be impossible to obtain a concentrate that would run better than 50 per cent. iron. In one case drilling operations have been carried on but the record of this work was not available. It is unlikely that the surface outcrops of the iron formation will yield any high-grade ore. In no case did the writer estimate the iron content of an outcrop at more than 35 per cent. iron and the analyses show that in, at least, three cases which were looked upon as more favourable than the average, the estimate was slightly high. The estimate in the field was based upon the width of the jaspilyte and magnetite bands as outlined in the writer's report[2] on the Hunter Island deposits.

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[1] A portion of the tails from .05 was lost. Assuming 36 grams to be dust which would be lost, the remaining 200 grams were distributed in the .07 and the tails.

[2] Ont. Bur. Mines, Vol. XXV, 1916, Pt. 1, p. 167.

Methods of Development

Two methods of developing these ores are possible: open quarry work on the low grade outcrop with subsequent concentration, or diamond drilling to ascertain whether there is a better grade of ore at depth. The first method will give a large tonnage, but it is doubtful whether, under present conditions, a high grade concentrate can be made at a profit. The second method offers little hope in view of the results of Robinson's survey. From a structural point of view there should be a deposit underlying the valley. Robinson's map, however, shows distinct breaks between the main deposits on the two sides of the syncline. For the final proving of the extent of the deposits it will be necessary to drill, and the writer is of the opinion that approximatingly flat lying iron formation will be found underneath the valley. Whether it will be of better grade than the outcrops is decidedly doubtful, but so far as can be seen, the only chance of finding high grade ore lies in drilling. Tunnels and test pits have been opened on most of the claims, so that the quality of the surface can be said to be proven. Results of analyses were given by one of the operators which, while slightly higher than the results obtained from the writer's samples, are in practical agreement.

Calculation of Iron Content

In estimating the percentage of iron in a deposit such as the one under consideration, use may be made of the determination of the specific gravity of the ore as a means of avoiding the expense of unnecessary analyses. In general it may be stated that an ore which has a specific gravity of less than 4.1 will be not marketable without concentration, and one whose specific gravity is less than 3.67 will not pay to concentrate. Pure magnetite and pure hematite each have a specific gravity of about 5, while 2.67 is the specific gravity of quartz. If we know the specific gravity of the ore (G), the percentage of iron present can be calculated with sufficient accuracy (within two per cent.) for preliminary work by means of of the following formula:

$$\frac{G-2.67}{5-2.67} \times 70 = \text{Percentage of iron.}$$

Boulder Clay

An interesting feature of the great terrace of the Kaministikwia valley is shown in a cut on the Canadian National railway about three quarters of a mile north of Crest, where there is a deposit of boulder clay (Fig. 1.) in which at least one distinct bedding plane is visible. That this was deposited by ice can hardly be doubted, but in view of the bedded character it is difficult to look upon it as ordinary moraine material. It is equally difficult to conceive of a five foot bed of this material forming as the result of a single freshet piling up ice laden with clay, sand and boulders, which is a second possible explanation. This boulder clay is underlain by loose gravel and overlain by a thin sandy deposit which is covered by clay soil, all of which are evidently deposited from water, so that the accumulation of this material by the piling up of blocks of ice laden with debris seems very probable. Deposits several inches in thickness have been observed by the writer in the process of formation in regions where the sediment was principally sand and clay, and in numerous instances boulder ridges have been observed in northern lakes which can hardly be explained, except by transportation by floating ice.

Steeprock Lake

A short time was spent on Steeprock Lake in an attempt to secure data in connection with the possible extension of the iron deposits under the lake. Little positive data could be obtained. It has been shown, however, that flat lying bodies of iron ore, even when strongly magnetic, exert no influence on the dip needle[1] so that in a region where iron ore is known to occur it is necessary before condemning a particular property to have not only an accurate magnetic map, but a detailed geological map showing not only the surface outcrops, but the structural geology as well.

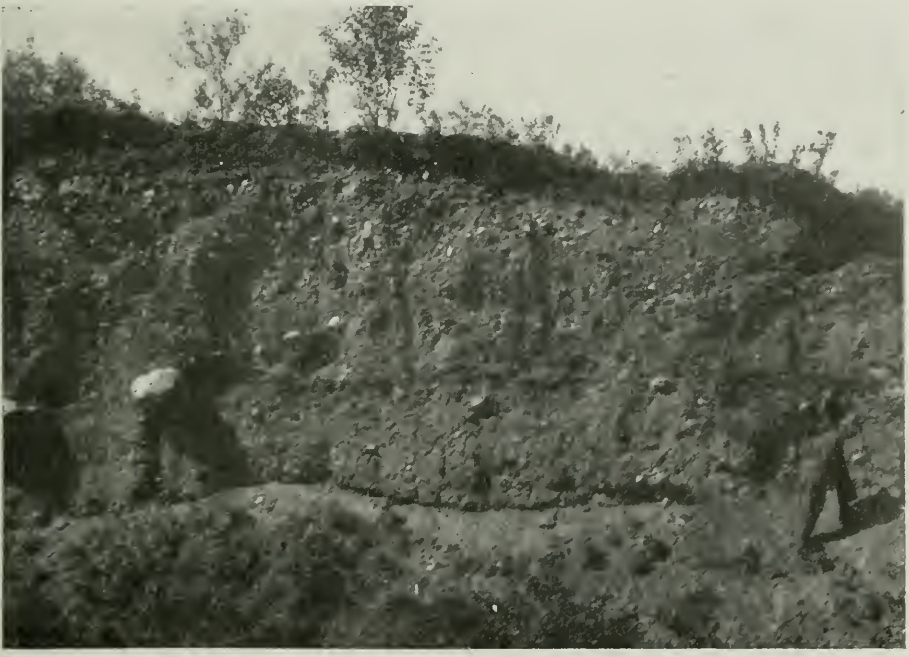

Fig. 1.—Bedded boulder clay near Crest, Ont.

Silver

During the time the writer was in the field, interest in silver mining was concentrated on the Silver Islet mine near Thunder cape, and the Federal mine in Paipoonge township. In addition to visiting these two mines the writer visited many of the mines to the west of Port Arthur, known as the Silver Mountain area, as well as some of the old zinc-lead mines in Thunder Bay district. These latter were visited, as it was found that in every case the silver mines of this district carried zinc blende and galena, and it was thought that the silver-bearing veins were of the same origin and age as the lead-zinc veins.

A comparative list of minerals from this district and the Cobalt area was given by N. L. Bowen[2], which shows a wonderful similarity in the two areas. This, however, is only partially complete, as the following tabulation of the minerals seen at various mines will indicate.

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[1] Broderick, T. M., Econ. Geol., Vol. 13, No. 1, pp 35-49, 1918.

[2] Ont. Bur. Mines, Vol. XX, 1911, Pt. I, p. 128.

MINERALS OBSERVED AT SILVER MINES AND PROSPECTS.

MINERAL	Silver Islet	W. End Silver Mtn.	Gopher mine	E. End Silver Mtn.	Badger	Porcupine	Anorthite shaft	Edward Isld.	Dorion (lead & zinc)	Bishops mine	Blende Lake	Beaver	Federal
Silver........	x	x				x							
Mercury......	x												
Graphite......	x												
Niccolite......	x												
Smaltite......	x												
or													
Chloanthite...	x												
Argentite.....	x	x				x							x
Galena.......	x		x			x	x	x	x		x	x	x
Sphalerite.....	x	x	x	x	x	x	x	x	x		x	x	x
Pyrite........		x			x	x	?		x				
Marcasite.....	x						x					x	x
Pyrrhotite....													
Chalcopyrite..													
Bornite.......													
Proustite.....													
Animikite.....	x												
Macfarlanite..	x												
Calcite.......	x	x	x	x	x	x	x	x	x	x	x	x	x
Fluorite......	x	x		x	x	x						x	x
Dolomite.....	x				x		x						
Quartz.......	x	x	x	x	x	x	x	x	x	x	x	x	x
Barite........													
Siderite.......				x	x		?						
Annabergite...	x												
Malachite.....									x	x			

In using this list for comparative purposes it must be borne in mind that in most cases the mines were closed down and full of water or ice, so that the material to be used in making a judgment had to be secured from the dump. This readily explains the lack of silver and argentite in the list for many of the mines. In general it may be said that the veins of this district consist principally of calcite, quartz (in part amethystine), fluorite, galena, sphalerite, marcasite, argentite and silver. In the case of the Silver Islet mine to the above must be added niccolite, smaltite or chloanthite, mercury (probably in the form of arquerite), annabergite and dolomite with possibly huntelite. The nature of animikite and macfarlanite is discussed elsewhere in this report.

The admirable descriptions of the mines of this district given by Ingall[1] and Bowen[2] make further description of those that are not working, undesirable. The only point that could be added is that nature is gradually restoring the landscape to the condition that existed before the mines were opened. It is only when new work is done that further information of value can be obtained.

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[1] G. S. C. Ann. Rep. 1886, Pt. H.

[2] Ont. Bur. Min., Vol. XX, 1911, Pt. 1, pp. 119-132.

Origin of the Silver Ores.

So far as work has shown, the silver bearing veins are located in the Animikie slates and post-Animikie diabase sills, flows and dikes. The mineral content of the veins, however, is not all such as is commonly supposed to be due to basic igneous rocks, though a part of the minerals are usually found in veins in such rocks. The experience at Cobalt has shown that the nickel-cobalt minerals are almost invariably in the diabase, as well as in the sedimentary rocks, and while silver is found in the granite, it is by no means so common as in the diabase. The peculiar feature of the Thunder Bay silver veins that seems to point to another source for part of the vein material is the universal presence of fluorite which is more commonly supposed to be connected with the emanations from an acid magma such as granite, though found also with phonolyte and andesite. In the case of the Dorion lead and zinc mines it is difficult to assume any other origin, as these veins are near the granite contact, and little if any basic rock is present. In the other mines visited the case is not so clear as granite exposures are not near at hand. In discussing a similar series of ores in the Ainsworth mining camp in British Columbia, Schofield[1] attributes the origin to solutions emanating from granite in the pneumatolitic stage of cooling on the ground that fluorite is a common gangue mineral.

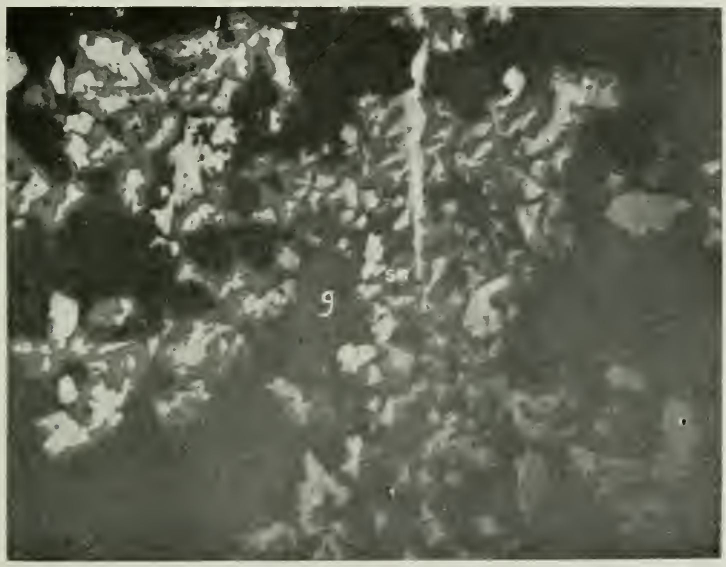

Fig. 2.—Macfarlanite—(s m)) Smaltite, (g) galena (white mineral) silver.

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[1] Geol. Surv. Can., Mem. 117, p. 36.

Silver Islet Mine

This mine, which was operated from 1869 to 1884 and produced approximately 3,000,000 ounces of silver, was partially pumped out during the summer of 1920 by R. C. Jamison and D. C. Peacock, Duluth, Minn., for the purpose of sampling the roof and first level. It was popularly supposed that the roof was broken so that it would be impossible to unwater the mine, but the first day's pumping showed this to be incorrect as the water was lowered 45 feet in the shaft. The entire work of pumping was done with compressed air and the first level was kept free from water until the sampling was completed. A mill and smelter sample was taken from the roof, and as autumn approached the machinery was removed to the main land for the winter. During the winter diamond-drilling has been in progress, and it is hoped that the results of this work will supplement the favourable results secured in the roof of the mine. In January, 1921, the Islet Exploration Company, Limited, of which Mr. Peacock is the manager, was incorporated under the laws of Ontario.

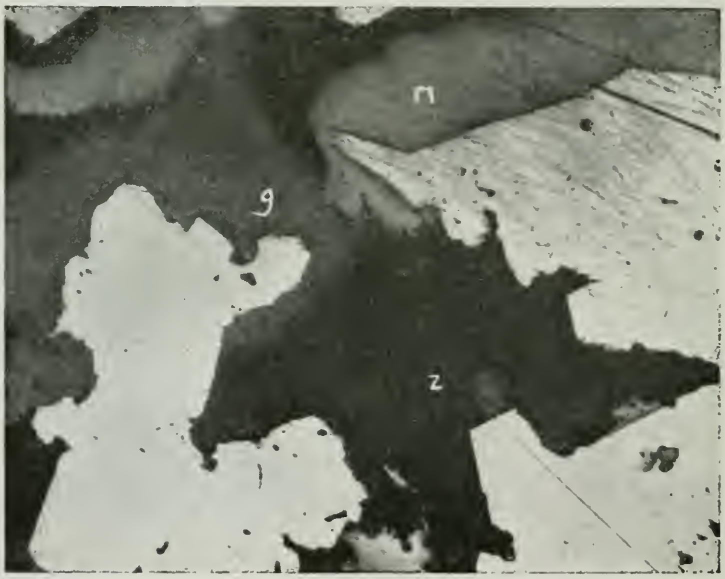

Fig. 3.—Macfarlanite—(n) niccolite, (g) galena, (z) zinc blende, (white mineral) silver.

The ore showing in the roof of the mine is largely macfarlanite with native silver, argentite, galena and sphalerite. In order to ascertain the nature of the macfarlanite numerous samples were taken and through the kindness of Ellis Thomson, of the University of Toronto, a mineralographic study has been made which shows conclusively that this material is an intimate mixture of silver, niccolite, smaltite-chloanthite, galena, and sphalerite, which is the typical association in the Cobalt area. The order of deposition as shown in the illustrations (Figs. 2 and 3) is apparently galena and sphalerite, probably crystallizing contemporaneously, followed by silver which is frequently completely inclosed by niccolite.

Inasmuch as the early analysis by Macfarlane[1] showed the only constituents to be silver, mercury, nickel, antimony and arsenic, and recalculation of the analysis showed that the arsenic and antimony were present in the proper proportion to form niccolite and breithauptite, it was deemed advisable to have an analysis made to settle definitely the much-mooted question of a compound of silver with arsenic or antimony in the material. In preparing the specimen it was impossible to get absolutely pure material but from the mineralographic study it was definitely known that the material contained silver, niccolite, smaltite, galena, sphalerite and dolomite. After picking out as much dolomite as possible the sample was crushed in an agate mortar, and screened on a sixty-mesh sieve. The oversize and fines were analyzed separately by E. W. Todd, in the Mineralogical Laboratory of the University of Toronto, and the results combined in proportion to the weights of the two portions, to give the average composition of the ore. The results follow:

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[1] Trans. A. I. M. E. Vol. 8, p. 238.

COMPOSITION OF MACFARLANITE.

Schedule	Oversize		Fines		Average	
	percentage	molecular proportion	percentage	molecular proportion	percentage	molecular proportion
Ag........	79.91	.731	12.44	.115	32.54	.302
Pb........	2.01	.010	20.31	.098	14.86	.072
Zn........	0.26	.004	0.94	.014	0.59	.009
S..........	1.22	.038	4.42	.141	3.46	.108
As........	5.40	.072	12.27	.164	10.23	.135
Sb........	0.48	.004	0.72	.006	0.65	.054
Hg.......	0.84	.004	0.21	.001	0.39	.002
Ni........	4.29	.073	9.42	.161	7.92	.135
Co........	0.31	.005	0.82	.014	0.66	.011
Fe........	0.20	.004	0.44	.008	0.37	.007
Ca O.....	1.18	.021	14.15	.251	10.29	.181
Mg O....	0.64	.016	6.55	.163	4.80	.119
CO_2	1.40	.032	17.78	.414	12.55	.285
Total...	98.14	....	100.47	....	99.30	....

In making the analysis it was necessary to make the determinations of zinc, sulphur, lime and magnesia, and carbon dioxide on separate portions, so that the recalculation of the analysis which follows shows a few minor variations from the results that would be demanded by theory. In the scales the following minerals were recalculated.

Mineral	Molecular proportions						Percentage
Dolomite...............	Ca O	.016	Mg O	.016	CO_2	.032	2.94
excess of..............	Ca O	.005	....				(0.28)
Marcasite..............	Fe	.004	S	.008			0.45
Galena..................	Pb	.010	S	.010			2.33
Sphalerite..............	Zn	.004	S	.004			0.39
Breithauptite...........	Ni	.004	S C	.004			.71
Niccolite...............	Ni	.069	As	.069			9.20
Cobaltite...............	Co	.005	As	.003	S	.007	0.78
Argentite...............	Ag	.018	S	.009			2.26
Silver...................	Ag	.713	....				77.94
Mercury................	Hg	.004	....				0.84

It will be noted that there is a slight excess of lime above the carbon dioxide ratio which is readily accounted for because these were determined on different portions. In calculating cobaltite, sulphur is here assumed to replace arsenic. The mercury is undoubtedly amalgamated with the silver forming arquerite, which adds to the resemblance of this material to the cobalt silver ores which frequently yield as much as four per cent. of mercury from the silver.

The fine material yielded the same materials with the exception of argentite which was absent and calcite which is probably indicated by the excess of lime in the first analysis.

Mineral	Molecular proportions						Percentage
Dolomite	Ca O	.163	Mg O	.163	CO_2	.326	30.54
Calcite	Ca O	.088	CO_2	.088			7.94
Marcasite	Fe	.008	S	.016			0.94
Galena	Pb	.098	S	.098			23.38
Sphalerite	Zn	.014	S	.014			1.38
Breithauptite	Ni	.006	Sb	.006			1.07
Niccolite	Ni	.155	As	.155			20.66
Cobaltite	Co	.014	As	.009	S	.013	1.92
Silver	Ag	.115					12.44
Mercury	Hg	.001					0.21

It will be noted that in both these analyses when the nickel and cobalt have combined with the requisite amount of arsenic and antimony there is no excess of these latter to combine with the silver. In fact, there is a slight deficiency in arsenic in both analyses which is in direct proportion to the cobalt content. If we assume the presence of a very small amount of temiskamite in place of part of the niccolite, this discrepancy would disappear but this mineral was not recognized in the mineralographic examination.

From this examination it is definitely shown that in the Silver Islet mine the material that has been known as macfarlanite is a mixture of the minerals that are characteristic of the Cobalt area, and that these were deposited later than the argentite, galena and sphalerite which are characteristic of the other mines in the Port Arthur region. It is also of considerable interest and probably of economic importance to note that this association is found in the dolomite and not in a vein which is principally calcite.

In connection with the examination of macfarlanite a sample of animikite which was obtained from the dump was examined by Mr. Thomson who found that it consisted of the same minerals as the macfarlanite. The sample was not large enough to furnish material for an analysis, but in view of the confirmation by the analyses of Mr. Thomson's findings in the case of macfarlanite there appears to be no reason to make an analysis. This material must also be considered a mixture. No specimen of huntelite, the third material which has been looked upon as peculiar to this mine, was obtained.

In order to show the nature and size of the Silver Islet vein, photographs of the roof of the stope were taken. The width shown in Figure 4 is from ten to twelve feet. The light coloured vein material consists principally of dolomite which is decidedly rich in macfarlanite, sphalerite and galena. The brecciated character of the vein is well shown, but the apparent tapering of the veins is due in large part to the fact that the roof is sloping so that the lower part of the picture is much farther from the camera than the upper part. Figure 5 shows a closer view of another portion of the vein and illustrates the remarkable brecciation that is shown throughout the upper level. The greatest width of vein material that was mined was about twenty-four feet and was at the junction of the two main veins on the first level.

An interesting feature of the mining operations at Silver Islet is the plan that evidently has been adopted to recover the ore from the roof. Inasmuch as it is estimated that several hundred thousand ounces of silver remain in the roof, the re-

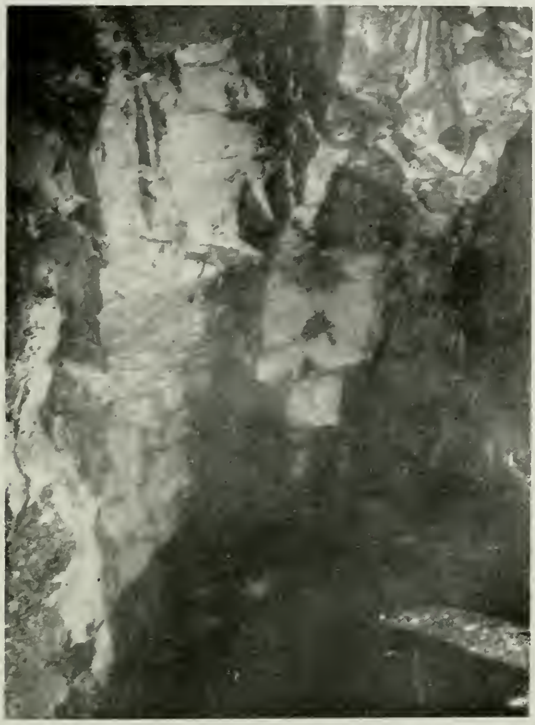


Fig. 4—Roof of stope showing Silver Islet vein.

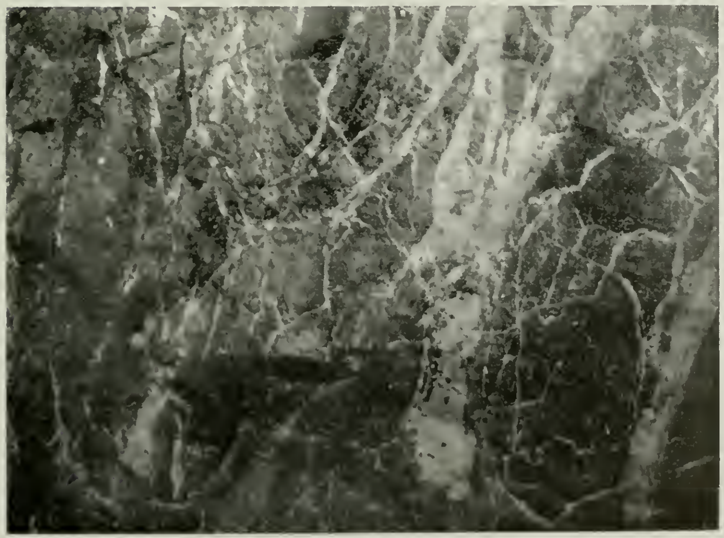


Fig. 5—Closer view of Silver Islet vein, showing brecciation.

covery of this is an important item. To do this without drowning out the mine was a problem. Just below the roof a ledge about three feet wide has been cut in the wall so as to give a good passage-way practically the entire length of the workings. It was evidently the intention to roof this over with concrete after which the roof was to be blasted and the loose rock then dredged from above. It is certain that no other method would provide for the recovery of the roof and further working of the mine. The unexpected closing down of the mine, however, left this work for a later development.

Federal Mine

A shaft about forty feet deep has been sunk at the Federal mine in Paipoonge township on a strong vein which is about five feet wide. The vein material is principally quartz and calcite, but with these there are fluorite, barite, marcasite, galena, sphalerite, argentite and silver. Most of the silver value is present in the form of argentite, and it was reported by F. S. Wiley, who is developing the property, that the average value obtained in sinking is about thirteen ounces of silver. The association is the same as that exhibited by the other West End mines, and so far the values have been found in crossing the Animikie slate.

Calcite

In all the veins of the region, calcite is found in abundance and when crystals are found in vugs, the form varies in a remarkable degree. When several minerals are crystallizing from a solution it has been found that they frequently exert a decided influence on the forms that will appear on the various substances, so that in certain cases it is possible to indicate the conditions which prevailed at the time when a substance crystallized by the forms present on the crystal.

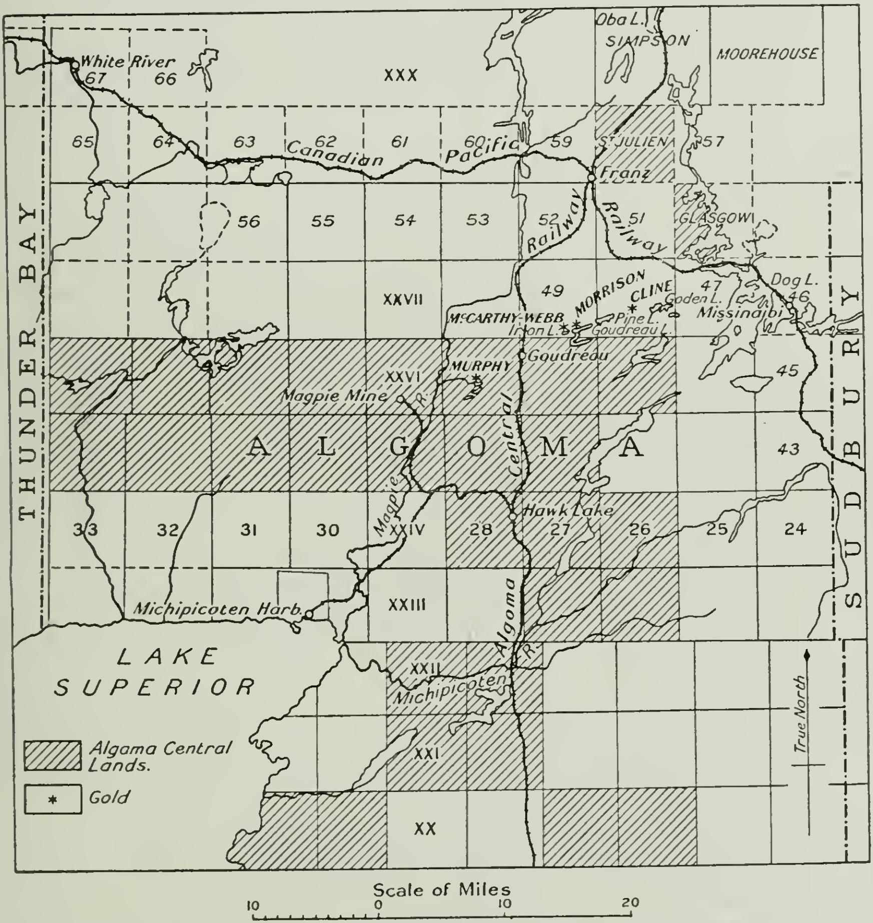
A vein in which calcite of two ages occurs was found on the north side of the Shangoinaw island about a mile west of Silver islet. So far as observed, no other mineral was present, so that the conditions appear to be the simplest possible. The older generation of calcite has been partially dissolved, presumably by rain water, so as to present a tabular aspect. Upon these crystals a new growth started giving crystals that are nearly colourless and free from cleavage cracks so that in some cases the calcite is probably fit for optical use. The surface is somewhat frosted so that the remarkable clearness is seen only when a crystal is split. These crystals show the unit rhombohedron as the dominant form but in addition show the base as well as several other forms which are principally scalenohedrons. Some of these forms are new for this mineral, and it is thought that the combination shown here represents the material that crystallizes from water containing carbon dioxide (rain water) at the temperature of Lake Superior water in the summer months, at a pressure not to exceed two atmospheres.

The study of the crystal form of this calcite, while yielding no immediate economic results has a bearing on the deposition of ores and further work may yield information of considerable value. In preparing crystals of various substances in the laboratory it has been shown that the same substance will develop entirely different combinations of crystal faces, depending upon the nature of the solution from which the crystals are formed and the pressure. The difficulty in the case of mineral deposits is to ascertain the nature of the solution from which a particular mineral crystallizes. It has been shown by experience that the habit of crystals of a given mineral in a given mineral association is fairly uniform, so that a mineral like calcite which is almost universal as a vein mineral, might well serve as an index to the particular stage of ore deposition that had been reached in a particular vein or portion of a vein.

NOTES ON THE GOUDREAU GOLD AREA

By A. G. Burrows

In accordance with my instructions of 22nd June, 1921, I proceeded to Goudreau station on the Algoma Central railway, to examine the recent gold find on the Murphy claims which are located in township 28, range XXVI, district of Algoma. This township is included in the land grant of the Algoma Central Railway Company, and claims staked in it are recorded at that company's office at Sault Ste. Marie.



Key map showing location of Goudreau gold area, Algoma district. The Murphy claims are located in Township 28, Range XXVI.

Means of Access

The area is most conveniently reached from Franz, a station at the crossing of the Canadian Pacific and Algoma Central railways. Goudreau, the nearest railway station to the gold discovery, is 17 miles southward from Franz; the Murphy claims are about 3½ miles southwestward from Goudreau. The camp is reached by a good canoe route starting one-half mile south of the station.

The route, which requires about two hours' travelling, is by way of Jackson, Long, Doherty, Aitken and Murphy lakes. The longest portage is about one mile. The find is located near the north shore of Murphy lake on mining claims 407 and 408.

Discovery

The discovery was made by Thos. Murphy of Goudreau while engaged in fur trapping in the month of April 1921. A. V. J. Selkirk, of Franz, merchant, and Jas. Perry, Goudreau, were early partners with Mr. Murphy; later, several others were given interests in the claims. Twelve claims in the vicinity of Murphy lake were staked by these gentlemen. At the time of my visit the claims were being examined by C. G. Daimpré for A. R. Porter of Toronto. Mr. Porter was on the ground, and before leaving procured an option on that part of the property on which the gold-bearing veins are located.

Geology

The rocks in the area to the southwest of Goudreau are dominantly basic volcanics of Keewatin age. Rocks of this character were observed from Goudreau all along the portage route to Murphy lake. The ellipsoidal structure, with amygdules so characteristic of much of the Keewatin, is frequently seen. In places the basic lava contains considerable carbonate, and is lighter-coloured than the normal dark-coloured rock. Most of the lavas are altered to schist, which has a general strike nearly east and west. With the lavas there is a small amount of banded iron formation, magnetite and silica, seen on claims 408 and 412. In the vicinity of Goudreau the main iron formation zone is prominent. Two of the large iron pyrites properties, the Goudreau mine of the Nichols Chemical Company, and the Rand Consolidated Mines, are near Goudreau; neither of these being in operation at the time of inspection.

With the basic volcanics in the vicinity of Murphy lake there are several intrusions of quartz porphyry or quartz-feldspar porphyry; these acid rocks are generally schistose like the darker lavas. Some of the quartz-porphyry occurs as dikes cross-cutting the strike of the lava flows. One small mass of porphyry intrusive into the basic rock can be observed on the north line of claim 407.

A mass of grey granite, gneissic in places, occurs on several claims to the west of the gold discovery.

Several narrow dikes of the diabase with a N.-S. strike cut the older formations. One of these along the east line of claim 459, is an olivine diabase. The rock relationships are illustrated in the accompanying geological sketch map.

Veins

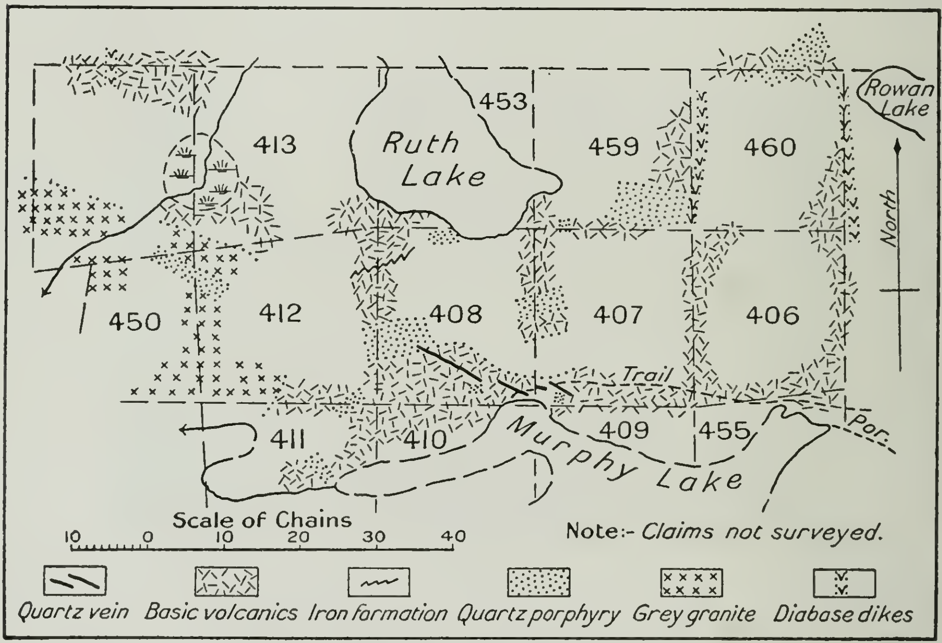
Gold was first discovered in a quartz vein in the southeastly part of claim 408 (Murphy), where for a distance of about 20 feet along the hanging-wall side of the vein, there are a number of showings of quite coarse gold in the quartz. The quartz vein has been traced by trenching, and outcrops for about 800 feet on claim 408. It strikes approximately N 70° W, and the dip, where observable, is from 60° to 80° S. It varies in width from seven inches to three feet. Along the quartz vein the wall rock has been altered in places to a rusty schist containing ankerite and sericite, and carrying quartz veinlets together with sulphides at different points. The width of the altered rock appears to vary greatly, but owing to the small amount of cross-trenching, the width of the possible mineralized wall rock could not be determined. The hanging-wall contact of the quartz and schist is more definite than the footwall. At the location of the gold showings the vein, including the wall rock, is about 3 feet in width, while 15 feet to the north is a subsidiary quartz vein a foot in width, to the north of which is a band of ankerite. Twenty feet to the west this smaller vein is only 3 feet from the main vein. The quartz vein in places is well mineralized with pyrites, copper pyrites and pyrrhotite; 150 feet southeasterly from the above showing, the quartz vein is about 7 inches in width, and in a band of sugary quartz and schist on the hanging-wall, visible gold was seen.

Work has also been done on claim 407 to the east. At the west line, 200 feet north of Murphy lake, a narrow quartz vein about a foot in width has been traced 65 feet; it strikes S 80° E. The wall rock for a few inches is quite rusty, and carries sulphides. Visible gold was observed at two points along the vein. About 200 feet easterly from the west line work has been done on a wide ankerite-schist band up to 20 feet in width, which carries quartz veins roughly parallel to the ankerite band. It has been traced for 170 feet in a direction S 70° E. No visible gold was observed in this vein, but at one point an assay of $6.00 in gold was obtained over a width of 2ft. 9 in. of quartz, and $4.00 in gold over a width of 5 ft. 6 in. of the schist and carbonate, carrying quartz, lying to the north. Owing to the highly altered character of the schist by oxidation, the latter assay is only indicative of the presence of gold, and may represent concentration. The quartz vein carries pyrite, copper pyrites, pyrrhotite, and a little zinc blende. It is possible that this easterly vein is the faulted part of the vein exposed on claim 408.

Gold bearing quartz vein, Murphy claim (Goudreau Gold Mines), showing hanging wall contact with Keewatin rock. White quartz is about two feet wide in foreground, while the foot-wall is silicified rock. Visible gold occurs in the outcrop.

A geological sketch map showing the approximate location of the veins on claims 407 and 408 accompanies these notes. A number of assays of samples obtained at points along the veins showed gold values ranging from a few cents to $28.00 per ton. None of the assays were taken from points where visible gold was seen. In addition, two essays were made of specimens of quartz carrying a high percentage of sulphides, from a pit a few feet west of the rich gold showings, which gave $31.20 and $48.80 in gold.

The property, however, was not in condition for any thorough sampling, since few cross trenches had been made exposing the walls of the vein, and none below the superficial oxidation. The main vein shows high grade ore for at least 40 feet near the discovery, but extensive work will be required to determine the possible ore shoots, since large portions of the vein are concealed by drift. Cross trenches and blasting to the unoxidized vein, preparatory to sampling, will be carried on, and it is expected that a shaft will be sunk on or near the rich section of the main vein.



Geological sketch map showing veins on claims 407 and 408.

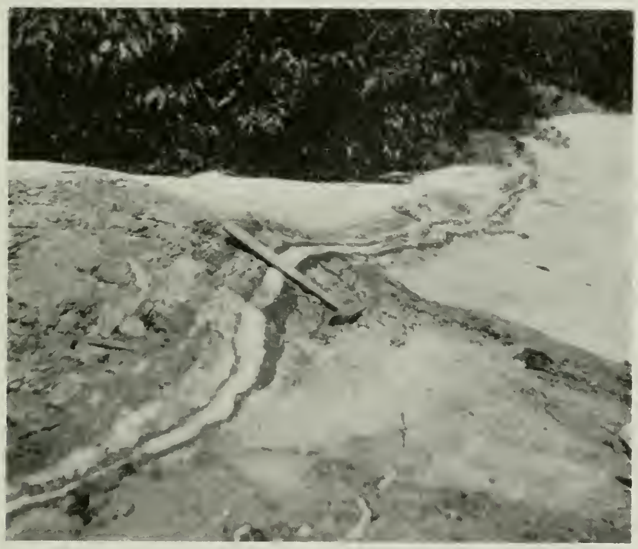
From later information it appears that trenching about 500 feet westerly from the original discovery exposed the vein showing visible gold in greater abundance than in the shoot farther east. Two shafts have been sunk to moderate depths, namely, 40 feet and 43 feet, and a third to a depth of 6 feet. On the installation of hydro-electric power, mining operations will be resumed.

The property was taken over by C. A. Foster in the fall of 1921, and a company known as the Goudreau Gold Mines has been organized. A mining plant including a 10-drill compressor has been installed on the property. The nearest available hydro-electric power is at Magpie mine, from which point a transmission line has been constructed to the Goudreau Gold Mines.

Townships 48 and 49

A short trip under the guidance of Jas. Cline, a prospector, was made northeastward from Goudreau in townships 49 and 48, range 27. Gold has been discovered on a number of claims between Goudreau station and Goden lake, which lies in the southeast part of township 48.

McCarthy-Webb.—The McCarthy-Webb group of claims 2049, 2050, etc. near Iron lake, has been described by W. H. Collins[1] in his report on the Magpie-Hawk area. Briefly, the rock is a schistose porphyry which, in places, is a quartz-porphyry with a strike N 84° E mag. Shear zones occur in the porphyry, and these are indicated by a rusty surface containing vague quartz veinlets, which is in marked contrast to the white porphyry. The rusty streaks are very irregular in length and breadth, being from a few inches to a few feet in width, containing fine-grained iron pyrites. Gold in a very fine state has been found in the rusty zones. In addition, there are widely separated transverse veinlets of quartz carrying much tourmaline, in which coarse gold has been discovered. These veins are more definite than those running with the schist. The property has been sampled several times, particularly in one place for a length of 100 feet, where the rusty condition is most pronounced.



Transverse gold bearing quartz vein carrying massive tourmaline, Morrison claim 2025, north of Goudreau lake. The dark rock in the foreground is schistose basalt. The lighter rock in the background is schistose quartz porphyry.

Morrison.—The Morrison claim, 2075, on the north shore of Goudreau lake, is similar to the McCarthy in structure. However, the rusty zones running with the schist are less pronounced, while there are more of the transverse quartz-tourmaline veins. Visible gold has been found in a number of the narrow veins which are parallel to the schist, and also in the transverse veins. The main shears, about a foot in width, strike from N 66° to N 86° E, whereas the cross veinlets strike N 6° E. The latter vary from a fraction of one inch to 14 inches in width, and are too widely spaced to mine together.

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[1] Geol. Sur. Canada, Summary Report, Pt. E., 1918.

Cline.—A number of claims about 1½ miles northeast of Pine lake were also visited. Visible gold was seen on claims 2186 and 2189. The rocks are Keewatin schist in which narrow quartz veins have been formed. A shaft was sunk 25 feet on claim 2189, on a quartz vein from 1½ inches to six inches in width, in which there is a high percentage of sulphides, also visible gold. The extension of the vein to the west where it is cut by a diabase dike, has not been found.

On claim 2186 there is one narrow rich quartz vein about 5 inches wide, in which gold has been found over a length of 20 feet. A second vein from 8 inches to 3 feet wide occurs on the claim. It consists of quartz and schist, on which a 5-foot pit has been sunk. Material from this vein showed much gold in panning. Owing to the heavy drift covering, it is difficult to trace the veins any distance.

Some rusty shear zones were also observed on claims 2183 and 2184. On claim 2184 in one trench the rusty zone is 15 feet in width, which diminishes rapidly to the west. Some visible gold is reported near the north wall. Sufficient work has not been done on any of these claims to determine their value.

Literature

The geological reports on the Michipicoten area for the greater part refer to the iron ranges. These reports include those by W. H. Collins[1], J. M. Bell[2], A. P. Coleman[3], and A. L. Parsons[4]. W. H. Collins, in his report refers to the gold area to the northeast of Goudreau. His geological map of the Goudreau Pyrite Area extends westward to within a mile and a quarter of the Murphy claims.

At the time these notes were made Ellis Thomson was in the field for the Geological Survey, continuing the mapping of the area begun by W. H. Collins. His work will include an examination of the area southwest of Goudreau in which the Murphy claims are located, and the area near Pine lake.

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[1] The ore deposits of Goudreau and Magpie-Hawk Areas, Michipicoten, Ont., Geol. Sur. Canada, 1918, Part E.

[2] Iron Ranges of Michipicoten West, 14th report, Ont. Bur. Mines, 1905, Part I.

[3] Michipicoten Iron Region, Coleman and Willmott, 11th report, Ont. Bur. Mines, 1902.

[4] The productive area of the Michipicoten Iron Ranges, 24th report, Ont. Bur. Mines, 1914, Part I.

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I—Natural Gas in 1920

II—Oil Field Operations, 1920

By

E. S. ESTLIN, COMMISSIONER OF NATURAL GAS

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NATURAL GAS IN 1920

By E. S. Estlin, Commissioner of Natural Gas

Work of the Year

Certain amendments to the Natural Gas Act 1919 were submitted to the Legislature in the session of 1920 but were eventually withdrawn, consequently the Act remained unchanged except as regards a slight amendment giving the Natural Gas Commissioner authority to administer an oath and take an affidavit, statutory declaration or evidence under oath in any part of Ontario.[1]

During the months of February and March, the Commissioner was occupied chiefly in holding inquiry into the general situation at some of the important centres in the natural gas area, a full account of which has been published in the Twenty-ninth Annual Report of the Ontario Department of Mines, 1920, Part V. The evidence submitted at these inquiries was transcribed from the stenographer's notes and bound in a separate volume covering the Inquiry held at each of the following places: Sarnia, Windsor, Chatham, Hamilton and Woodstock. These volumes are on file in the Department of Mines, at Toronto.

Many matters pertaining to the Natural Gas Industry, which come within the Commissioner's jurisdiction, have been dealt with during the course of the year: these will be treated briefly in this report under separate headings.

In dealing with matters under complaint, making adjustments and regulating the gas service and supply generally, official enquiries were held and evidence heard respecting conditions at the following places:—

Aldborough
Barton Tp.
Belmont
Brantford
Bridgeburg
Canfield
Chatham
Dorchester
Dunnville
Dunwich Tp.
Dutton
Fingal.
Fonthill
Galt
Hagersville
Hamilton
Ingersoll
London
Moulton Tp.
Oil Springs
Paris
Port Burwell
Rodney
Sarnia
Simcoe
Southwold Tp.
St. Catherines
Stevensville
Vienna
Wallaceburg
Wellandport
Welland
West Lorne
Windsor
Woodstock

Complaints reach the Commissioner's office from time to time regarding damage done by unplugged wells. Some such complaints were made the subject of special investigation by the Inspectors during the year. This is a task that required much experience, because it is most difficult to determine just where the trouble lies. When a case of this kind is put in the hands of the Inspector, it is carefully watched until the remedy has been determined upon and applied.

In reviewing the events throughout the year, it may be said that 1920 has been a year of special interest to those who have taken an active part in the natural gas problems of Ontario.

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[1] An Act to Amend the Natural Gas Act, 1919.

The Relief Natural Gas Company withdrew from active operations altogether, and as part of their main supply line was owned by other interests, the pipe was taken up and disposed of. In this way, the connection between the wells and the villages of Fonthill and Ridgeville and township of Pelham was cut off, leaving these districts without any gas supply. This matter was met by the Commissioner's office obtaining a junction with the adjacent high pressure line belonging to the United Gas Companies, and gas was purchased from this Company and distributed through the remaining distributing system of the Relief Company, by the courtesy of A. H. Trappnell, the liquidator.

The National Gas Company, Limited, sought permission to remove and dispose of their twenty-one mile pipe-line consisting of 8, 10 and12-inch pipes laid between the Seneca gas field and the city of Hamilton.

This company had formerly delivered the output of its wells to the Dominion Natural Gas Company for distribution in Hamilton, who conveyed the gas through its own lines, hence the expense of maintaining this valuable line by the National Company was considered unnecessary.

The Southern Ontario Gas Company constructed a pipe-line in Kent County at a cost reported to exceed $100,000 to tap the wells of the independent producers in Dover township. This makes a fairly direct connection between the Company's main pipe-lines at the field end in Tilbury township.

The formation of the Municipal Gas Consumers' Association was one of the events of the year. This organization grew out of the negotiations that were being carried on between the Natural Gas interests and the municipalities regarding the matter of rates, and is composed of representatives of certain municipalities having franchises with the Gas Companies: the present secretary is H. H. Hallatt, Tilbury.

The effort to obtain increased rates put forth by the natural gas interests, with a view to preserving and maintaining the industry, was successful in many localities, and a slight upward trend of prices was observed. But in Essex, Kent and Lambton counties, the increase took the form of a temporary rate of forty cents the Gas company agreeing to deposit the difference between that price and the franchise rate with the treasurer of the municipality, to be subsequently disposed of when a scale of permanent rates could be reached.

Near the end of the summer the rate controversy reached such a pitch that the gas company discontinued the supply to the towns of Essex, Tilbury, Blenheim, Dresden and Ridgetown, this action being in violation of a special order previously served on all gas companies. The situation was met by the appointment of special agents of the Commissioner at each town, who proceeded to restore the service.

An important organization was formed towards the end of the year called the Union Development Company, Limited. This company is carrying on drilling operations in Dawn township and has two rigs now at work equipped for deep drilling.

Orders issued by Commissioner

The following orders were issued by the Commissioner during the year:—

ORDER No 6: Dated January, 31st, 1920, restraining the Chatham, Wallaceburg and Lake Erie Railway Co. from using natural gas in a steam power boiler.

ORDERS No 7 & 9: Dated January 7th and June 9th, 1920, respectively, in respect of the turning into the lines of the Union Natural Gas Company of the gas production from the Petrol Natural Gas Company's well in Dover township.

Orders Nos. 8A, 8B, 8C, 8D.: Dated January, 10th, 1920, respecting the continuing of gas supply to the town of Aylmer.

Order No. 10: Dated July 30th, 1920, restricting the use of gas throughout the district served by the Provincial Natural Gas Co., Ltd., to cooking and heating of tap water only.

Order No 11: Issued September, 1st, 1920, in respect of the use of natural gas for industrial purposes without permit.

Order No 12: Issued September 1st, 1920, respecting the limiting of the use of gas obtained from the wells of the Provincial Natural Gas Co., Ltd.

Order No. 13: Issued October 25th, 1920, requiring the continuation of gas service in all localities by all Natural Gas companies.

Order No. 14: Issued December 20th, 1920, cancelling Order No. 9.

Order No. 15: Issued December 28th, 1920, forbidding the use of natural gas from the wells of the Union Natural Gas Company for heating purposes in public buildings.

Order No. 16: Issued December 28th, 1920, restraining the use of natural gas for heating purposes in Tillsonburg, Vienna, Aylmer, Port Burwell, Straffordville, Bayham Township.

Order No. 17: Issued December 29th, 1920, restraining the use of natural gas for heating purposes, and otherwise controlling the service in the town of Oil Springs.

Protecting the remaining Natural Gas Supply

It is intended to show under this heading the efforts that have been made by the Department in co-operation with the several gas companies for prolonging and conserving the gas flow in the various districts.

Deliberate and sustained effort to carry on development work in the form of new drilling was not undertaken to any great extent during the year. The reason given for this inactivity was that labor and price of equipment having reached a high level, the return from the sales of natural gas under the old rates, was inadequate; therefore, the producers turned their attention to protecting the resources of their present wells by devising and putting into practice many methods for checking waste and improving the service equipment.

"Unaccounted=For" Gas Supplied For Distribution

The practice of selling gas to a distributing company on a percentage basis figured on consumers' returns has a recognized disadvantage to the producing company, inasmuch as the latter carries the waste. A large proportion of the gas supplied from the Kent gas area is delivered under this arrangement.

Orifice meters, which measure gas volume under high pressures, have been brought to such a high standard of efficiency within the last few years, that it is now possible to determine comparative results of delivery and output, whereas in the past the output has only been checked from service meter returns.. Producing companies installed a number of these instruments throughout the year on their main lines, and the records are beginning to be of great value as a practical guide to certain necessary economies in the business.

These meters were placed at the junction of the producing company's main lines with the lines serving many cities and towns. The result has been that a comparison of the difference between the amount delivered into a town with the amount metered out to consumers was made possible, and corrective measures were adopted to check the difference thus brought to light. Table No. 1. gives some idea of the percentage of "unaccounted-for" gas occurring between delivery and consumption.

TABLE I.—PERCENTAGE OF LOST GAS UNDER DIFFERENT SELLING METHODS.

Case 1—
Where distributing companies purchase gas on a percentage basis, that is, the producer takes a percentage of the distributing company's receipts.

	Gas Supplied M. cu. ft.	Gas Sold M. cu. ft.	Gas Lost M. cu. ft.	Loss Percentage
A.	1,048,346	879,208	169,138	16.1
B.	191,373	157,129	34,244	17.9

Case 2.—
Where gas is supplied and distributed by one company.

A.	144,851	132,251	12,600	8.7
B.	187,662	170,609	17,053	9.1

Case 3.—
Where gas is bought and paid for by the distributing company at town border.

A.	156,989	153,475	3,514	2.2
B.	160,168	155,230	4,938	3.1

It will be noted from the above figures that there is an enormous difference in "lost and unaccounted-for" gas where the gas is purchased by the distributing company through town-border meters, as against the producer taking a percentage of the distributing companies' receipts. The figures quoted in Table No. 1. are the actual returns from measurements made during the year. Two instances are cited in each case to show the results under varying volume delivered.

Gas Losses in Syndicate or Private Lines

In carrying further this principle of measuring gas "wholesale," some attention has been given to instances where gas is delivered from high pressure lines into private or syndicate lines. These are cases where several rural consumers club together and lay a small line along a side road for the purpose of serving members of the syndicate. In some instances the producing companies have taken over the upkeep of these lines, and in others the line itself has been put in by the gas company under an annual rental paid by the consumers in addition to the current rate; but in most cases these lines are privately owned, and heretofore the gas has been turned in direct from the high pressure pipeline and regulated and metered at each dwelling.

The installation of meters at the high pressure end of syndicate lines is telling a tale of waste through leakage that calls for immediate remedial measures. Efforts are being made to correct the waste by apportioning the difference between the readings of the main line meter and the private meters, amongst the consumers and this will no doubt have the effect of reducing the amount of waste and improving upkeep of the lines. A conservative estimate of the total length of syndicate and private lines in the gas area is approximately 600 miles. These lines are usually of small diameter and require gas at high pressure to overcome the frictional resistance, so that the leakage is much greater than in the case of low pressure mains. It is regrettable that statistics dealing with this phase of gas waste cannot be quoted here for the reason that the method of dealing with it as described, has been put in operation but recently, and figures are not obtainable.

Where gas is sold to consumers directly off the high pressure lines considerable waste has also occurred because of the practice of weighting the arm of the regulator which controls the pressure between the customer's meter and the high pressure line. These service lines are often too small rof thte purpose, and in many cases equipment in the residence is not in good condition. The consumer finds relief by placing a weight on the arm of the regulator and taking into the service line all the pressure the meter will stand. The result is that the relief valve on the regulator releases the surplus gas pressure and a very considerable waste results. If the relief vlve failed to function, the diaphragm of the meter would probably blow up under the increased pressure. Gas companies are meeting this difficulty by installing a safety device between the meter and the residence, (*see* diagram) which acts as a relief valve if excess pressure is put on, with this difference, that all gas so wasted is measured and paid for.

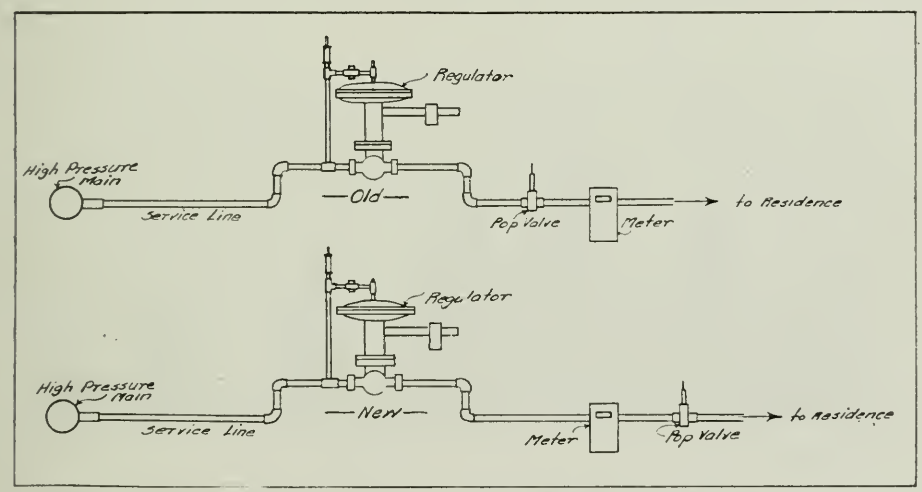

Diagram showing high pressure service with position of pop valve in both old and new style method of installation.

In connection with this particular form of waste, fifty regulators were examined, all weighted down, (a few of them having fence rails laid across the arm) and the pop-valves were all blowing gas into the atmosphere. This waste occurred before the gas reached the meter. In one case dealt with through the Commissioner's office the consumer himself checked the amount lost, by closing off all burners and reading the meter, which registered ten cubic feet per hour. In this case, the relief valve was blowing gas for eight hours. At this rate, if 500 of these regulators were tampered with and allowed to release pressure enough to open the blow-off, the loss would approximate forty-five million cubic feet per annum, or about enough fuel to keep three hundred families for a year.

Controlling Industrial Consumption

Not the least part of the work of restraining excessive consumption has been directed towards reducing the industrial or commercial use of gas. Many references to this phase of the Departmental work have been made in previous reports, but it has not been possible heretofore, to publish a comparative table showing the actual decline since the Department first put in force restrictive measures, because the returns have not been available.

TABLE II—INDUSTRIAL CONSUMPTION OF GAS FOR FOUR YEARS.

	cu. ft.
In 1917 the consumption of gas in Industries was	9,124,752,000
" 1918 " " " " " " "	2,744,866,000
" 1919 " " " " " " "	1,584,479,000
" 1920 " " " " " " "	1,423,825,000

These figures demonstrate the effectiveness of the permit system operated under the Natural Gas Act 1919. In the main, the permits have not been abused, otherwise the results shown in Table No. III, could not have been obtained. The reduction of nearly six and a half billion cubic feet of gas in the year 1918, meant that the factories, which relinquished the bulk of this gas, had to substitute some 250,000 tons of coal, and to remodel their furnace equipment in order to change fuels, and this was accomplished while the war was still in progress.

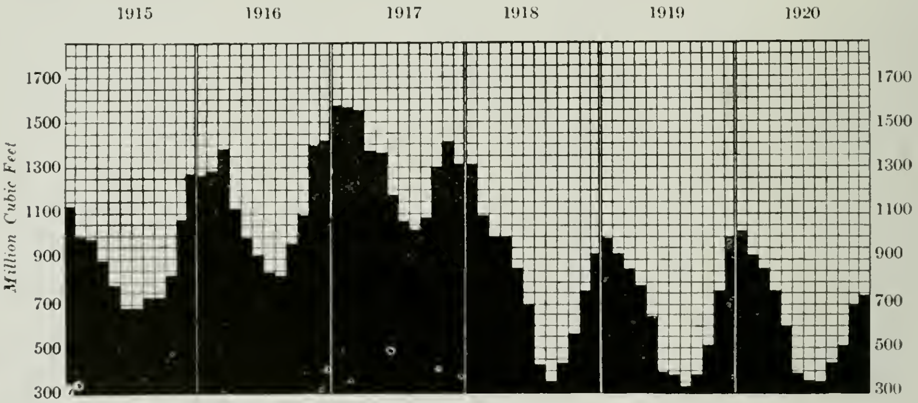

Chart showing monthly consumption of natural gas from the Kent field, 1915-1920 inclusive.

By examining the chart showing the monthly consumption of gas taken from the Kent gas field, for six years, it will be noticed that during the year 1917, the heaviest output of the wells was experienced; the decline during the summer months of that year being negligible, because of the immense industrial consumption shown in Table No. 3. The chart also indicates the effect upon the annual consumption of the withdral of six and a half billion cuble feet from factory use in 1918, to which reference has been made. Summer consumption for the past three years, as shown by this chart, has about reached a normal level, which hereafter will only be affected by varying rates. These rates, if increased, will have a tendency to bring down the higher levels, indicating winter consumption, which no restrictive measures can do.

This chart also indicates this other interesting fact, that if the 1917 consumption had not been regulated when it was, it is very doubtful whether the 1919 and 1920 section of the chart would have appeared in these pages at all.

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[1] Rep. Ont. Bur. Mines, Vol. XXVIII, 1919, Pt. 1, p. 61.

The following table is useful in tracing the natural gas supply as it rose and fell during a period of fifteen years.

TABLE III.—NATURAL GAS PRODUCTION FOR 15 YEARS IN MILLION CUBIC FEET

Year	Cu. ft.	Year	Cu. ft.	Year	Cu. ft.
1906	2,534.2	1911	12,311.9	1916	17,929.1
1907	4,155.9	1912	12,454.9	1917	20,026.0
1908	4,483.0	1913	12,558.4	1918	13,067.4
1909	5,388.0	1914	14,062.8	1919	11,195.3
1910	7,263.3	1915	15,212.3	1920	10,545.0

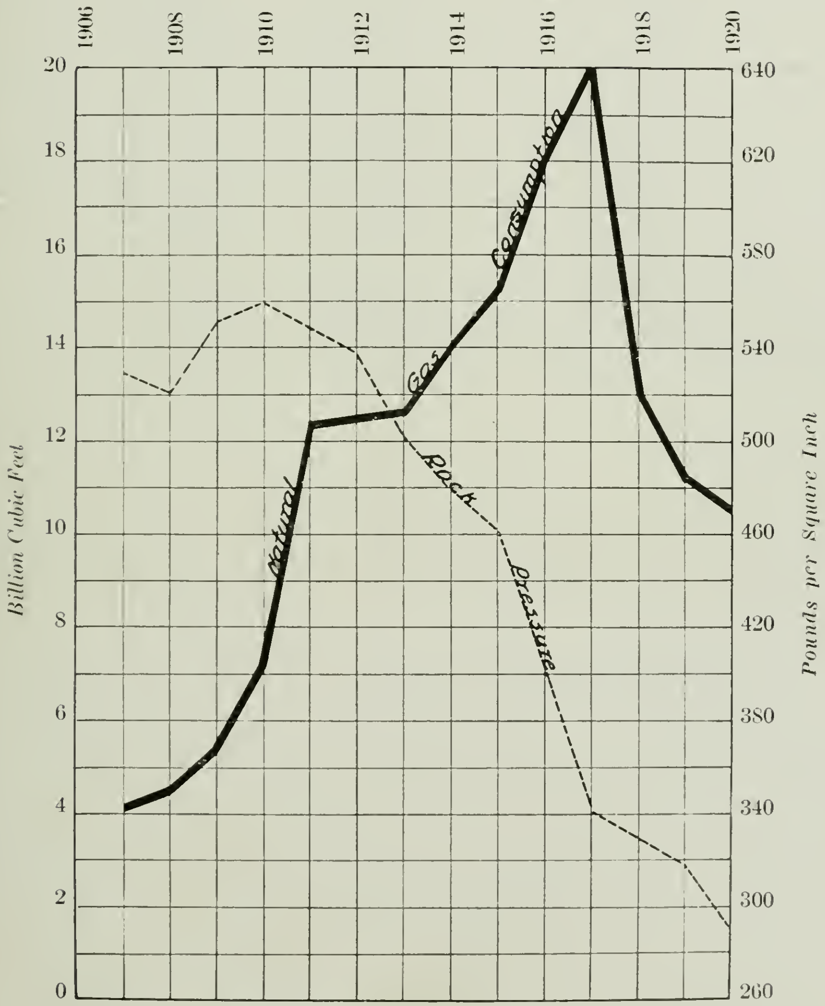

Chart showing relation between consumption and rock pressure.

Another chart indicating the relation of field pressures to consumption requires very little explanation. Although the consumption peak was reached in 1917 and delivery from the fields fell away very rapidly immediately thereafter, the steady decline in field pressures continued. No figures can express more plainly the great need of a vigorous search for new fields outside of the area affected by these reduced pressures.

TABLE IV.—URBAN CONSUMPTION OF NATURAL GAS 1919 AND 1920

Municipality	1919	1920
	cu. ft.	cu. ft.
Brantford	251,837,000	175,732,000
Chatham	1,019,916,000	1,014,799,000
Coatsworth	28,772,000	61,495,000
Dresden	66,754,700	78,094,000
Essex	69,165,400	76,691,000
Galt	144,733,000	103,386,000
Hamilton	1,012,292,000	604,116,000
Ingersoll	157,700,000	158,232,000
Kingsville	80,464,000	114,087,000
Leamington	178,495,000	205,509,000
Paris	70,580,000	66,277,000
Petrolia	142,638,300	139,661,100
Ridgetown	79,053,500	104,580,000
Sarnia	597,685,000	603,640,000
Tupperville	7,740,500	10,807,000
Tilbury	74,111,000	70,987,000
Tecumseh	23,605,400	22,574,000
Windsor	1,754,223,000	1,611,640,000
Woodstock	194,371,000	159,947,000
Wheatley	35,739,000	42,585,000
Total	5,989,875,800	5,424,839,100

Field Measurements

Table V showing "open-flow" measurements, refers to the method gas operators use, in "feeling the pulse" of each well. The term "open-flow" has given rise to considerable misunderstanding when used by those not accustomed to the operations of a gas field. The following explanation will perhaps help to make the use of the table plain.

The open-flow of a gas well is the amount of gas that is blown from the open well into the air; this flow is measured by a "U" gauge containing either water or mercury. One end of the "U" gauge is held in the gas stream, and the displacement of mercury or water caused by pressure, is recorded in inches and tenths. The flow of gas is worked out per 24 hours by applying the gauge-reading to a table which takes into account the size of the outlet, etc. It is misleading to the public to quote the output of a gas well measured in this way as representing the merchantable production of the well, because after the gas-flow is inclosed and flowing against the line pressure on its way to service, the actual delivery of the wells is only a fraction of the "open-flow."

TABLE V.—OPEN FLOW MEASUREMENT OF GAS WELLS IN KENT COUNTY

The Table refers to the Tilbury gas field only, and the well measurements are 162 cubic feet per 24 hours.

	1916	1917	1918	1919	1920
Union Natural Gas Co....	116 Wells	132 Wells	134 Wells	133 Wells	136 Wells
	69,042,388	58,165,100	40,086,647	33,773,487	23,346,764
Percentage of Decline....	....	16 per cent	31 per cent	17 per cent	30 per cent
Glenwood Natural Gas Co	82 Wells	92 Wells	91 Wells	99 Wells	106 Wells
	60,128,000	93,319,080	28,198,926	22,863,000	16,980,000
Percentage of Decline or Increase.	....	55 per cent increase.	70 per cent decline.	20 per cent decline.	27 per cent decline.

This system of measuring gas in the field is useful in keeping check upon the behaviour of a well and in watching its decline. As all wells have to be "blown down" to a normal flow before the gauge is applied, the condition of the well whether wet, dry, or showing oil and so on, is indicated, and treatment may be decided upon for the season.

Table V indicates the pronounced failing of the Tilbury wells over a period of five years. In 1917 the Glenwood field showed 55 per cent. increase over the 1916 measurements. This was due to the fact that among the ten new wells added to the field, one well which gauged thirteen million cubic feet per twenty-four hours was brought in. It did not long survive, as the figures show. The varying number of the wells has to be considered in using the comparison in the table because it is constantly changing, new ones being added, abandoned wells plugged, and some being laid up for repairs.

The figures in Table V show in an impressive way the need of retrenchment in the field of consumption if the amount of gas remaining in this locality is going to meet the "peak demand" another year. It will also be seen at a glance that a reduction in the consumption of available gas became an absolute necessity when the first serious shortage occurred in 1917-18, in order that the domestic requiremets might be met at critical periods.

Effects of Price on Consumption

In dealing with the work of regulating consumption, it is necessary to refer to the controlling influence that price has upon the consumption of gas. The following list of municipalities and towns shows the disparity of rates at which natural gas was produced and sold in the different sections of the gas area. The rates given were in force during 1919 and 1920 generally, and are quoted here for statistical purposes also for comparison with some higher rates since established, with reference to the effect upon conservation.

CITIES AND TOWNS USING GAS, AND RATES CHARGED IN 1919 AND 1920

Place	Distributing Company	Rate per M. cu. ft.	
Attercliffe	Dominion Natural Gas Company	.40	
Ancaster	Manufacturers Natural Gas Co. Ltd	.80	
Acacia	Dominion Natural Gas Company		
Aylmer	Central Pipeline Company	.40	.60
Bridgeburg	Provincial Natural Gas Company	.50	
Binbrook	Binbrook Gas Company	.40	
Blackheath	Dominion Natural Gas Company	.25	
Blenheim	Union Natural Gas Company...	.25	
Brigden	Union Natural Gas Company...	.30	
Baldoon			
Buxton North	Glenwood Natural Gas Company	.15	
Buxton South	Glenwood Natural Gas Company	.15	
Belle River	Union Natural Gas Company	.30	
Brantford	Brantford Gas Company	.80	
Belmont	Belmont Gas-Light Company	.70	
Bartonville	Dominion Natural Gas Company	.40	
Chippawa	Chippawa Development Company		
Crowland			
Crystal Beach	Provincial Natural Gas Co.	.75	
Caledonia	Port Colborne-Welland N. G. Co.	.40	
Caistorville		.25	
Cedar Springs	Union Natural Gas Company	.15	
Coppleston			
Corunna	Union Natural Gas Company	.30	
Courtright	Union Natural Gas Company	.30	
Chatham	Chatham Gas Company	.25	
Charing Cross	Union Natural Gas Company	.15	.20
Coatsworth	Glenwood Natural Gas Company	.15	
Comber	Union Natural Gas Company	.30	
Cottam	Beaver Oil & Gas Company	.25	
Clanbrassil			
Cayuga	Dominion Natural Gas Company	.45	
S. Cayuga	“ “ “ “	.40	
Cainsville	“ “ “ “	.30	
Cheapside	“ “ “ “	.25	
Chedoke	“ “ “ “	.70	
Dunnville	“ “ “ “	.40	
Dundas	“ “ “ “	.70	
Dover Centre	Union Natural Gas Company	.25	
Dealtown	“ “ “ “		
Dresden	“ “ “ “	.30	
Decewsville	“ “ “ “		
Delhi	Dominion Natural Gas Co.	.45	
Dorchester	Southern Ontario Gas Co.	.40	
Dutton	Southern Ontario Gas Co.	.30	
Elfrida	Dominion Natural Gas Co.	.40	
Essex	Union Natural Gas Co.	.30	
Eden	Dominion Natural Gas Co.	.40	
Elmstead	Union Natural Gas Co.		
Fonthill	United Gas Co.	.75	
Fletcher	Union Natural Gas Co.	.15	
Ford	Windsor Gas Co.	.30	
Fisherville	Fisherville Gas Co.		
Frome	Southern Ontario Gas Co.	.35	
Fingal	Southern Ontario Gas Co.	.35	
Fenwick	United Gas Co.	.75	
Fort Erie	Provincial Gas Co.	.50	
Fairground	Dominion Natural Gas Co.	.45	
Guild	Union Natural Gas Co.	.15	
Galt	Dominion Natural Gas Co.	.80	
Humberstone	Sterling Natural Gas Co.	.75	
Hamilton	United Gas & Fuel Co.	.75	
	Dominion Natural Gas Co.	.75	
Hannon	National Gas Company		

List of Cities and Towns, etc. *Continued.*

Place	Distributing Company	Rate per M. cu. ft.
Highgate	Southern Ontario Gas Co. Union Natural Gas Co.	.20 .25
Hagersville	Manufacturers Nat. G. Co. Ltd.	.50
Hepworth	Northern Gas & Gasoline Co.	
Ingersoll	Ingersoll Gas-Light Co.	.80
Iona	Southern Ontario Gas Co.	.35
Jeanette's Creek	Union Natural Gas Co.	.20
Jarvis	Dominion Natural Gas Co.	.45
Kingsville	Beaver Oil & Gas Co.	.25
Kobler		
Lythmore	Dominion Natural Gas Co.	.40
Logierait		
Leamington	Beaver Oil & Gas Co.	.25
Lynne Valley	Dominion Natural Gas Co.	.45
Lyndoch	Dominion Natural Gas Co.	.45
London	Southern Ontario Gas Co.	.45
Lambeth	Southern Ontario Gas Co.	.45
Lowbanks	Sterling Natural Gas Co.	.25
Merritton	United Gas Companies.	.75
Muirkirk	Southern Ontario Gas Co.	.20
Mull		
Morpeth	Union Natural Gas Co.	.20
Mandamin		
Merlin	Glenwood Nat. G. Co. & Union Co.	.15
Maidstone	Union Natural Gas Co.	.25
Marshville		
Mount Salem	Southern Ontario Gas Co.	
Marthasville	Union Natural Gas Co.	
Niagara Falls	Provincial Natural Gas Co.	.50
North Ridge	Beaver Oil & Gas Co.	.25
Nelles Corners	Dominion Natural Gas Co.	.25
Nanticoke	Dominion Natural Gas Co.	.25
North Oxford	Southern Ontario Gas Co.	.80
Ouvry	Union Natural Gas Co.	.25
Olinda	Beaver Oil & Gas Co.	
Oil Springs	Oil Springs Oil & Gas Co.	
Onondaga	Dominion Natural Gas Co.	.80
Oldcastle		
Prairie Siding	Union Natural Gas Co.	.15
Palmyra	Union Natural Gas Co.	.25
Petrolia	Petrolia Utilities Co.	.30
Paris	Dominion Natural Gas Co.	.80
Putname	Southern Ontario Gas Co.	.60
Power Glenn		
Pelham N.	United Gas Co.	.75
Point Abino		
Point Edward	Sarnia Gas Co.	.30
Paincourt	Union Natural Gas Co.	.25
Ridgeway	Bertie Natural Gas Co.	
Rychmans	Dominion Natural Gas Co.	.35
Rodney	Southern Ontario Gas Co.	.28
Ridgetown	Union Natural Gas Co.	.25
Rondeau		
Romney	Union Natural Gas Co.	
Ruscomb	Union Natural Gas Co.	
Ruthven	Beaver Oil & Gas Co.	.25
Rainham Centre	Dominion Natural Gas Co.	.25
Rosehill	Rosehill Natural Gas Co.	.75
Ridgeville	United Gas Companies.	.75
Stevensville	Provincial Natural Gas Co.	.75
Sherkston	Provincial Natural Gas Co.	.50
Stromness		
Sinclairville		.25
Shetland	Shetland Gas Co.	

LIST OF CITIES AND TOWNS, ETC. *Continued.*

Place	Distributing Company	Rate per M. cu. ft.
Sarnia	Sarnia Gas Co.	.30
Sombra	Union Natural Gas Co.	.30
Sandwich	Windsor Gas Company	.30
Selkirk	Dominion Natural Gas Co.	.25
Springvale	Gas & Oil Co. of Springvale.	
Simcoe	Dominion Natural Gas Co.	.45
Straffordville	Dominion Natural Gas Co.	.40
Shedden	Southern Ontario Gas Co.	.35
St. Catharines	United Gas Companies.	.75
St. George	Dominion Natural Gas Co.	.80
St. Jacobs		
St. Williams	Dominion Natural Gas Co.	.45
St. Joachim	Union Natural Gas Co.	.25
Thorold	United Gas Companies, Ltd.	.75
Tilbury	Union Natural Gas Co.	.25
Tecumseh	Union Natural Gas Co.	.25
Tupperville	Union Natural Gas Co.	.30
Tillsonburg	Dominion Natural Gas Co.	.45
Talbotville	Southern Ontario Gas Co.	.35
Valetta	Union Natural Gas Co.	.15
Vittoria	Dominion Natural Gas Co.	.45
Vienna	Dominion Natural Gas Co. Central Pipeline Co.	.40 .15
Welland	Provincial Natural Gas Co. Industrial Natural Gas Co.	.50
Wellandport	J. A. Coleman	
Woodburn	Woodburn Gas Co.	.30
Wilkesport	Union Natural Gas Co.	
Wallaceburg	Wallaceburg Gas Co.	
Wheatley	Beaver Oil & Gas Co.	.25
Woodslee	Union Natural Gas Co.	
S. Woodslee	Union Natural Gas Co.	.25
Windsor	Windsor Gas Co.	.30
Walkerville	Windsor Gas Company	.30
Willow Grove		
Woodstock	Woodstock Gas-Light Co.	.80
Wilton Grove		
Wallacetown	Southern Ontario Gas Co.	.28
West Lorne	Southern Ontario Gas Co.	.28
Winger	Provincial Natural Gas Co.	
Port Burwell	Dominion Natural Gas Co. Central Pipeline Co.	.47 .23
Port Colborne	Sterling Natural Gas Co.	.52
Port Maitland	Dominion Natural Gas Co.	.25
Port Lambton	Union Natural Gas Company	.30
Port Ryerse	Dominion Natural Gas Co.	.45
Port Dover	Dominion Natural Gas Co.	.45
Port Rowan	Dominion Natural Gas Co.	.45
Port Royal	Dominion Natural Gas Co.	.45
TOWNSHIPS	AND LOCALITIES	
Drake Road	Glenwood Natural Gas Co.	.15
Middle Road Extension	Glenwood Natural Gas Co.	.20
Maple City Oil Co.	Glenwood Natural Gas Co.	.15
8th Concession, Raleigh Township	Glenwood Natural Gas Co.	.25
Westminster Township	Southern Ontario Gas Co.	.45
Southwold Township	Southern Ontario Gas Co.	.35
Dunwich Township	Southern Ontario Gas Co.	.28
Aldboro Township	Southern Ontario Gas Co.	.25
Orford Township	Southern Ontario Gas Co.	.20
Howard Township	Southern Ontario Gas Co.	.20
Raleigh Township	Southern Ontario Gas Co.	.15
Harwich Township	Southern Ontario Gas Co.	.15

While the efforts of the Department have been constantly directed toward the control and reduction of excessive consumption so that the partially exhausted fields might have a chance for longer life the work has been carried on mainly under the system of restriction provided in the statute. But the effective consumption governing principle of rate adjustment could not be applied, because the statute provides no powers to deal with the price at which natural gas should be bought or sold. Just how the price automatically effects consumption is shown in Table Number VI. The figures given represent the quantity of gas consumed per customer per annum. The steady fall in consumption as the price increases is most significant.

Table VI.—How Rates Affect Consumption.

	Cu. ft.
25 cents	161,000
30 "	143,000
35 "	128,000
40 "	114,000
45 "	102,000
50 "	92,000
60 "	75,000
75 "	57,000
$1.00	39,000

It is curious to note how the total domestic consumption works out when applied to the average rate. The average of all gas rates given in the list of Cities and Towns is 38.2 cents per thousand cubic feet, and this rate applied to Table VI works out at approximately 121,000 cubic feet consumed by each consumer in the year. This is confirmed by applying the rate to the curve in chart on page 15, also by comparing it with Table VIII which gives the actual amount consumed during 1918, 1919 and 1920 in various localities. The total amount of domestic gas consumed in the Province in 1920 divided by an estimated number of domestic consumers as shown in Table No. VII, gives 121,600 cubic feet used by each consumer per annum.

Table VII.—Relation of Total Consumers to Quantity Consumed.

	cu. ft.
Total consumption in Ontario, 1920	10,545,000
Less total industrial consumption	1,424,000
	9,121,000
Approximate total consumers	80,000
Less commercial users	5,000
Domestic users	75,000

$$\frac{75,000}{9,121,000} = 121,600 \text{ cu. ft. per consumer per annum.}$$

Again, if the 75,000 domestic consumers used 9,121,000 thousand cubic feet in 1920 for which they paid 38.2 cents per thousand cubic feet, the same consumers would use only 4,275,000 thousand cubic feet if they paid 75 cents per thousand cubic feet, because at the seventy-five cent rate their annual gas consumption would be 57,000 cubic feet each according to the rates given in Table VI. At 38.2 cents per thousand cubic feet the 75,000 domestic consumers burned 9,121,000 thousand cubic feet, for which they paid $3,484,222. At 75 cents per thousand cubic feet they would burn 4,275,000 thousand cubic feet, for which they would pay $3,206,250. The advantage is obvious: approximately one half of the amount of gas would be used by the consumers at a 75-cent rate, and the available supply would last twice as long.

For the purpose of comparing the rate effect upon consumption, Table VIII is given here showing actual returns from several localities in Ontario where gas was sold at varying rates, and the amounts used per consumer.

TABLE VIII.—ACTUAL QUANTITIES CONSUMED UNDER VARIOUS RATES.

PLACE	YEAR	RATE	NO. OF CONSUMERS	AVERAGE ANNUAL CONSUMPTION PER CAPITA
				cu. ft.
Ingersoll	1918	37.5	1,197	129,160
Ingersoll	1919	44.8	1,217	118,614
Simcoe	1918	29.1	2,751	145,176
Simcoe	1919	34 .5	2.727	124,661
Southern Ont. System	1920	15.0	106	164,424
Southern Ont. System	1920	20.	219	151,104
Southern Ont. System	1920	28.	519	149,376
Southern Ont. System	1920	30.	251	156,468
Southern Ont. System	1920	35.	231	126,336
Southern Ont. System	1920	40.	375	127,234
Southern Ont. System	1920	80.	11,067	45,191
Port Colborne System		20.		174,000
Port Colborne System		25.		162,000
Port Colborne System		40.		104,000
St. Catharines		73.		53,000

The chart[1] on page 15 puts the whole relationship of consumption to price in such plain form that the decrease in consumption consequent upon the increase of price, can be seen at a glance.

The general trend of the curve in this chart demonstrates also that as the higher prices are reached and natural gas passes into the luxury class, so the variation in comsumption becomes more gradual. That portion of the curve indicating the decrease in consumption from a dollar up would show approximately the same variation in the case of high grade artificial gas.

Loses by Defective Methods of Consumption

While the Department has given much consideration to statutory control of excessive consumption, the question of economical methods of consumption was not lost sight of during the year. It has been found that many consumers unconsciously waste at least twenty-five per cent. of the gas they pay for, because of the want of a little attention to the adjustment and condition of the equipment in which it is consumed. This is putting the loss at a conservative figure. Some startling statements have been given out from time to time by natural gas engineers dealing with the waste of gas in unsuitable and badly regulated burning equipment. This is how one eminent authority puts it: "The waste in the average cooking stove is about eighty-seven per cent. of the gas received."

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[1] Information for this chart was supplied through the courtesy of H. R. Davis, General Manager, Dominion Natural Gas Company, Buffalo.

With a view to checking up some of the conditions under which cooking gas was being used, the Department caused an inspection to be made in February, 1920. The inspector in charge of this work selected representative streets of a certain city with a view to getting an average of conditions over the whole city area. Eighty-three residences were visited, and the cooking appliances examined with the following results:—

18.0	per	cent.	required cleaning of burners.
25.3	"	"	required more air.
2.5	"	"	required position of mixer changed.
32.5	"	"	in good condition.
1.2	"	"	used hydro for cooking.
1.2	"	"	new equipment.
16.8	"	"	were using wood or coal with gas.
2.5	"	"	were in fair order.
100.0			

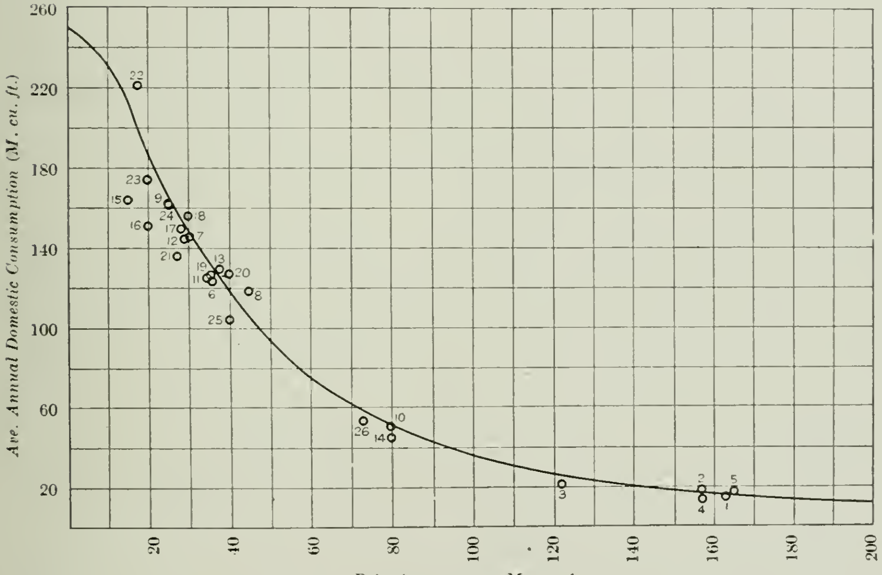

Chart showing relation of natural gas consumption to price.

It will be noted that 45.8 per cent. of these appliances were in bad order, and it is more than possible that many of the 16.8 per cent. using wood or coal with gas, were also out of order. For a conservative estimate of waste paid for by the householder, the defective 45.8 per cent. is added to a small proportion of the 16.8 to bring it up in round numbers to 50 per cent. Let us apply this to the whole cooking consumption of the Province for 1920, as follows:—

The total consumption of gas is divided into summer and winter periods, and the industrial consumption is deducted mainly from the summer portion, being confined principally to the warm months. The cooking gas is computed by doubling the consumption of the warm months, less the industrial, which gives approximately the following result:

	cu. ft.
Cooking Gas	6,210,800,000
Industrial Gas	1,424,000,000
Heating Gas	2,910,200,000
Total consumption for the Province for 1920	10,545,000,000

If we take the 45.8 per cent. defective cooking stoves before mentioned, and assume that there were enough defectives among the 16.8 per cent. using combined fuel to bring the total up to 50 per cent., we shall be close enough for the purpose of this calculation and was within the mark. Applying the 50 per cent. representing the defective cooking stoves, with the low estimated loss by improper combustion of 25 per cent., to the total cooking consumption for 1920, we find that 3,493,575,000 cubic feet were consumed by the fifty per cent. defectives and 2,717,225,000 cubic feet were consumed by the other 50 per cent., making up the aforementioned cooking total of 6,210,800,000 cubic feet. Therefore, a 25 per cent. loss through defective combustion represents a needless waste of about 21,000 cubic feet per defective cook-stove per year; or a total of gas paid for by the consumers from which no benefit was derived, of 776,350,000 cubic feet which at 38.2 cents per thousand cubic feet means unnecessary gas bills in this one item alone of approximately $295,565 in one year.

This startling result is based upon the assumption that the average of 50 per cent. defective apparatus shown in the eighty-three stoves examined, would apply to the whole Province.

There is no doubt that the amount of waste through improper combustion in ordinary cooking stoves to the amount indicated, possibly far more, is going on all the time, and that some effectual means of teaching consumers how to use gas economicaly should be carefully considered. Literature has been published and sent into every home, but still the waste goes on. A proportion of this inexcusable waste can be accounted for by the prevalence of low-priced gas, but not all. Gas which costs 25 cents per thousand cubic feet will be used with less attention to economy than gas which costs $1, on the same principle that tap water supplied by the city at say $2 per quarter is allowed to run from the tap without any attempt being made to utilize the whole amount passing through the tap; but if the size of the quarterly bill depended on the quantity of water drawn, more attention would be paid to turning the tap off.

Just what is the best way of meeting this and many other problems connected with needless waste of gas has been given much attention by administrative bodies, and by the gas interests as well, in the United States. The general opinion appears to be that higher rates are having the effect of making consumers more careful but not careful enough, and that it is necessary to deal with the apparatus itself by competent adjusters and experts, which of course is costly and takes time. With our reduced gas supply, some attempt will be necessary to show people how to obtain better combustion; this will appeal to consumers as more necessary when rates become higher, but the use of gas under lower distribution pressures will mean still greater necessity for adjustment of the burners. It is safe to say that natural gas will have to be consumed under constantly decreasing service pressure as the fields decline; this is the history of all gas fields.

Total Value of Natural Gas Consumed Since 1906

The total amount of natural gas consumed by the people of Ontario for the past fifteen years is in round numbers, 163,000,000,000 cubic feet, equivalent approximately, to 7,000,000 tons of coal. If an average rate of 20 cents was paid for this gas, then it cost the consumers $32,000,000 while the equivalent in coal of $7.00 per ton would have cost them, $49,000,000. The money for coal would have gone chiefly to the United States with a small proportion to other provinces, and freight would have been paid on it all. Added to this is the cost of stoking and removing the ashes. Putting this in another way, it may be said that by using gas instead of coal, the saving to the natural gas consumers of this Province amounts to about $1,133,000 per annum for the last fifteen years on a basis of the rates given in the foregoing calculation.

These figures are based upon typical prices, because it is nearly impossible to strike the actual rate at which all the gas was sold. Prices vary from time to time, and in the early days of the industry, gas was often sold at flat as well as graduated rates. It is quite probable that the gas rate quoted is high, but if a lower rate were used, it would only show a greater saving.

Licenses in the Gas Industry

There are five operations connected with the Natural Gas industry that are conducted under special annual license, the fee for which is ten dollars. These are (1) Leasing and Prospecting; (2) Operating Drilling Outfits; (3) Producing Operations; (4) Distributing Operations; (5) Operation of Pipelines. Thirty-eight licenses for "leasing and prospecting" were taken out for the year 1920 according to the following list:—

Operators Licensed to Lease and Prospect for Natural Gas 1920

License No.	Name	Address
47	Ajax Oil and Gas Co. Ltd.	Rowntree Bldg., Toronto, Ont.
39	Barr, D.	298 Talbot St., St. Thomas, Ont.
30	Beaver Oil and Gas Co.	Brantford, Ontario, (Buffalo, N.Y.)
34	Bermingham, T. F.	Hamilton, Ontario.
28	Castle Oil and Gas Co.,	Imperial Bank Bldg., Niagara Falls, Ont.
43	Central Development Co.	Chatham, Ontario
50	Cornish, J. H.	60 Summerhill Gardens, Toronto, Ont.
49	Diener, Eugene F.	R. R. No. 5, Dunnville, Ontario.
29	Dominion Natural Gas Co.,	Brantford, Ontario, (Buffalo, N.Y.)
45	Eureka Oil and Gas Co.	1804 Royal Bank Bldg., Toronto, Ont.
21	Frontier Oil and Gas Co. Ltd.	211 Liberty Bldg., Buffalo, N. Y.
31	Glenwood Natural Gas Co.	Brantford, Ont. (Buffalo, N.Y.)
51	Irvine, J. J.	Dunnville, Ontario.
48	Inland Oil & Gas Co. Ltd., E. P. Rowe, Sec.	608 Lumsden Bldg., Toronto, Ont.
38	Industrial Natural Gas Co.	Thorold, Ontario.
35	Jasperson, B.	Kingsville, Ontario.
55	Keyser, Bert L.	21 London St., Toronto, Ont.
22	Leeds, J. H.	Wellandport, Ontario.
42	Minor, L. E.	Smithville, Ontario.
36	May, A. G.	75 Melrose Ave., Hamilton, Ontario.
53	Mercer, F. D.	Toronto, Ontario.
23	Maple Leaf Oil and Gas Co.	48 St. John's Place, Buffalo, N.Y.
46	Northern Gas & Gasoline Co.	Hepworth, Ontario.
44	Petrol Oil & Gas Co., Ltd.	608 Lumsden Bldg., Toronto, Ont.
33	Provincial Natural Gas & Fuel Co.	Niagara Falls, Ont.
32	Pilkington Bros.	Thorold, Ontario.
24	Progressive Oil & Gas Co.	Room 38, Sun Life Bldg., Hamilton, Ont.
52	Peck, C. A.	96 Woolfrey Ave., Toronto, Ontario.
27	Quillinan, J. A.	Drawer 110, Imperial Bank Bldg., Niagara Falls.
25	Stewart, Alex.	Box 124, Windsor, Ontario.
37	Snively, F. L.	90 Melrose Ave., Hamilton, Ontario.
57	Universal Gas & Oil Co., Ltd.,	c/o Millar, Ferguson & Hunter, Crown Life Bldg., Toronto.
26	Union Natural Gas Company	Chatham, Ontario.
58	Valley Oil & Gas Co.	42 Home Bank Bldg., Hamilton, Ont.
56	Western Counties Gas Co.	E. C. Biden, Mgr. Dunnville, Ontario.
54	Winger, S. W.	R. R. 4, Hagersville, Ontario.
41	Waugh, S. A.	Fort Erie, Ontario.
40	Williams, A.	Ruthven, Ontario.

This is an increase of 19 operators over 1919.

Fifty-three operators took out "Producer's" Licenses as follows:—

Operators Licensed to Produce National Gas,1920.

License No.	Name	Address
88	Aldrich Gas & Oil Co.,	c/o Bruce & Counsell, Merchant's Bank Bldg., Hamilton, Ontario.
100	Beer, George	Binbrook, Ontario.
55	Beaver Oil & Gas Co.	Brantford, Ontario, (Buffalo)
95	Bertie Natural Gas Co.	Ridgeway, Ontario.
86	Battle, Martin	Sun Life Bldg., Hamilton, Ont.
96	Binbrook Gas Co.	N. Laidman, Binbrook, Ontario.
53	Castle Oil & Gas Co.	Niagara Falls, Ontario.
77	Chippawa Development Co.	Chippawa, Ontario.
60	Chippewa Oil & Gas Co.	Tavistock, Ontario.
92	Coleman, J. A.	Wellandport, Ontario.
64	Canfield Natural Gas Co.	Canfield, Ontario.
52	Canby, B. F.	R. R. No. 2, Marshville, Ontario.
76	Duxbury, Wellington	R. R. No. 1, Hagersville, Ont.
59	Darling Road Co-Operative Natural Gas Co.	Canfield, Ontario.
87	Dunn Natural Gas Co.	Dunnville, Ontario.
54	Dominion Natural Gas Co.	Brantford, Ontario (Buffalo)
99	Diener Gas & Manufacturing Co.	Dunnville, Ont., c/o Robt. Bradford.
63	Empire Limestone Co.	191 Hudson St., Buffalo, N.Y.
58	Emerson, Laidlaw & Troughton.	Attercliffe Station, Ont.
102	Eastside Gas Company.	Lowbanks, Ontario.
56	Glenwood Natural Gas Co.	Brantford, Ontario, (Buffalo.)
75	Hamilton Gas & Oil Co.	602 Spectator Bldg., Hamilton, Ont.
98	Hendee Gas Co.	c/o J. V. Fradenburg, Sec., Cayuga, Ontario.
82	Industrial Natural Gas Co.	Thorold, Ontario.
73	Jasperson, B.	Kingsville, Ontario.
94	Kindy, D. & Sons	Selkirk, Ontario.
93	Kindy Gas Company	R. R. No. 2, Cayuga, Ontario.
68	Lalor & Vokes	Dunnville, Ontario.
69	Lalor, F. R.	Dunnville, Ontario.
71	Liesinger & Lembke	42 Linden Park, Buffalo, N.Y.
78	Lamb, A.	Selkirk, Ontario.
79	Midfield Natural Gas Co.	Hamilton, Ontario.
90	Medina Natural Gas Co.	Chatham, Ontario.
85	Marshall, J.	Hamilton, Ontario.
81	National Gas Company	Hamilton, Ontario.
89	North Shore Gas Co.	c/o Bruce & Counsell, Hamilton, Ont.
51	Northern Gas & Gasoline Co.	Hepworth, Ontario.
74	Ontario Gypsum Company	Paris, Ontario.
66	Oil Springs Oil & Gas Co.	Oil Springs, Ontario.
67	Provincial Natural Gas Co.	Niagara Falls, Ontario.
80	Port Colborne-Welland Natural Gas Co.	Port Colborne, Ont.
62	Pilkington Bros.	Thorold, Ontario.
61	Petrol Oil & Gas Co.	1804-6 Royal Bank Bldg., Toronto, Ont.
72	Rolston & Bennett	Dunnville, Ontario.
101	Richmond Gas Co.	Chatham, Ontario.
83	Relief Gas Co., Ltd.	St. Catharines, Ontario.
91	Sparham, A. F.	R. R. No. 1, Caledonia, Ontario.
70	Sterling Natural Gas Co.	Port Colborne, Ontario.
97	Stevensville Natural Gas Co.	Stevensville, Ontario.
50	Union Natural Gas Co.	Chatham, Ontario.
57	United Gas Companies	St. Catharines, Ontario
65	Vacuum Oil & Gas Co.	608 Lumsden Bldg., Toronto.
84	Wainfleet & Moulton,	R. R. No. 1, Lowbanks, Ontario.

There was an increase of four in the list of producers over those operating in 1919.

Drilling Rig operations were licensed to the number of twenty-six; an increase of three over 1919.

OPERATORS LICENSED TO DRILL OR BORE FOR NATURAL GAS, 1920

License No.	Name	Address
29	Coleman, J. A.	Wellandport, Ontario.
30	Dominion Natural Gas Co.	Brantford, (Buffalo) No. 1.
31	Dominion Natural Gas Co.	Brantford, (Buffalo) No. 2.
49	Dundas Oil & Gas Co. Ltd.	807 Lumsden Bldg., Toronto.
38	Featherstone, C. W.	Canboro, Ontario, No. 1.
39	Featherstone, C. W.	Canboro, Ontario, No. 2.
32	Glenwood Natural Gas Co.	Brantford, Ont., (Buffalo.) No. 1.
33	Glenwood Natural Gas Co.	Brantford, Ont., (Buffalo) No. 2.
41	Industrial Natural Gas Co.	Thorold, Ontario.
24	Imperial Oil Co., Ltd.	56 Church St., Toronto.
45	Inland Oil & Gas Co.	502 Kent Bldg., Toronto.
35	Jasperson, B.	Kingsville, Ont.
44	Kiser, W. H. & Louer	Tillsonburg, Ontario.
25	McCutcheon, Thos. J.	Dunnville, Ontario.
43	McLister, J. J.	Dunnville, Ontario.
42	McKillop, Wm.	Hepworth, Ontario.
36	May, A. G.	75 Melrose Ave., Hamilton, Ontario.
34	Provincial Natural Gas Co.	Niagara Falls, Ontario.
26	Snively, F. L.	90 Melrose Ave., Hamilton, Ontario.
37	Snively, F. L.	90 Melrose Ave., Hamilton, Ontario.
27	Stewart, Alex	Box 124, Windsor, Ontario.
40	Stover Drilling Co., F. H.	110 Canfield Ave., Detroit, Michigan.
48	Snively, F. L.	90 Melrose Ave., Hamilton, Ontario.
47	Sparham, A. F.,	R. R. No. 1, Caledonia, Ontario.
28	Union Natural Gas Company	Chatham, Ontario.
46	Universal Gas & Oil Co., Ltd.	c/o Millar, Ferguson & Hunter. Crown Life Bldg., Toronto, Ont.

Nine Pipe-line licenses were issued, there being no increase in this division of the industry.

COMPANIES LICENSED TO OPERATE NATURAL GAS PIPE-LINES, 1920.

License No.	Nane	Address
14	Beaver Oil & Gas Company,	Brantford, Ontario, (Buffalo).
12	Castle Oil & Gas Company	Niagara Falls, Ontario.
18	Central Pipeline Company	Chatham, Ontario.
13	Dominion Natural Gas Co.	Brantford, (Buffalo.)
15	Glenwood Natural Gas Co.	Brantford, Ontario, (Buffalo.)
11	Northern Pipeline Company	Chatham, Ontario.
16	Southern Ontario Gas Company	Brantford, Ontario, (Buffalo.)
17	United Gas Companies	St. Catharines, Ontario.
10	Union Natural Gas Company	Chatham, Ontario.

Distributing Licenses to the number of forty-three were issued. an increase of four over those operating in 1919.

Operators Licensed to Distribute Natural Gas, 1920

License No.	Name	Address
68	Azoff Natural Gas Company	A. Baker, Treas., Canfield, Ontario.
80	Beer, George	Binbrook, Ontario.
75	Bertie Natural Gas Company	Ridgeway, Ontario.
60	Belmont Gas & Light Company,	Belmont, Ontario.
50	Brantford Gas Company	Brantford, Ontario, (Buffalo.)
46	Beaver Oil & Gas Company	Brantford, Ontario, (Buffalo.)
78	Binbrook Gas Company	N. Laidman, Binbrook, Ontario.
43	Coleman, J. A.	Wellandport, Ontario.
72	Central Pipeline Company	Chatham, Ontario.
62	Chippawa Development Company	Chippawa, Ontario.
65	Corporation of Town of Leamington	Box 209, Leamington, Ont.
61	Chatham Gas Company	Chatham, Ontario.
44	Castle Oil & Gas Company	Niagara Falls, Ontario.
81	Chippawa Oil and Gas Co.	Tavistock, Ontario.
45	Dominion Natural Gas Co.	Brantford, Ontario, (Buffalo.)
69	Dunn Natural Gas Co.	Dunnville, Ontario.
79	Erie Beach Gas Company	Chatham, Ontario.
70	Fisherville Gas Company	Fisherville, Ontario.
74	Gas & Oil Co. of Springvale	Hagersville, Ontario
47	Glenwood Natural Gas Co.	Brantford, Ontario, (Buffalo.)
82	High Grade Natural Gas Company	c/o R. L. Pattinson, Chatham, Ont.
66	Industrial Natural Gas Company	Thorold, Ontario.
52	Ingersoll Gas Light Company	Ingersoll, Ontario, (Buffalo.)
77	Lake Shore Natural Gas Company	294 Baynes St., Buffalo,
63	Midfield Natural Gas Co.	9 Maple Ave., Hamilton, Ont.
53	Manufacturers' Natural Gas Co.	Brantford, Ont. (Buffalo.)
42	Northern Gas & Gasoline Co.	Hepworth, Ontario.
55	Oil Springs Oil & Gas Company	Oil Springs ,Ontario.
40	Petrolia Utilities Company	Petrolia, Ontario.
56	Provincial Natural Gas & Fuel Co.	Niagara Falls, Ontario.
64	Port Colborne-Welland Natural Gas Co.	Port Colborne, Ontario.
67	Relief Gas Company	St. Catharines, Ontario.
71	Rosehill Natural Gas Co.	Buffalo, N.Y.
59	Sterling Gas Company	Port Colborne, Ontario.
54	Sarnia Gas Company	Sarnia, Ontario.
76	Shetland Gas Company	Florence, Ontario.
48	Southern Ontario Gas Company	Brantford, Ontario, (Buffalo.)
41	Union Natural Gas Company	Chatham, Ontario.
49	United Gas Companies,	St. Catharines, Ontario.
58	United Gas & Fuel Company	Hamilton, Ontario.
57	Windsor Gas Company	Windsor, Ontario.
73	Wallaceburg Gas Company,	Wallaceburg, Ontario.
51	Woodstock Gas Light Co.	Woodstock, Ont., (Buffalo).

In all, there were issued one hundred and sixty nine gas licenses for the year 1920.

During the three years that the Department has had jurisdiction over the Natural Gas service of the Province, two main problems have had to be constantly dealt with:—

(A).—Judicious restraining of excessive consumption;

(B).—Protecting the remaining supply.

The following remarks refer to different phases coming more particularly under "B."

Water Problem in the Gas Wells of Kent County

The life of the Tilbury gas fields is very seriously threatened by rock water which is constantly flowing into the wells. The influx of this water is somewhat retarded by maintaining as high a field pressure as possible, but as the general field pressure declines, the water increases. Table IX shows the annual decline of rock pressures.

TABLE IX.— ROCK PRESSURES, TILBURY GAS FIELD

Year	1913	1914	1915	1916	1917	1918	1919	1920
Lbs.	512	491	475	434	368	330	318	291

The conditions under which gas is usually encountered in this field do not admit of providing a pocket of sufficient depth to act as a reservoir for the water; for this reason frequent pumping has to be done. At the beginning of the year one gas company operated 166 producing wells in the Tilbury gas area, Kent county, 121 of which were more or less flooded, as outlined in Table X.

TABLE X.—PERCENTAGE OF WET WELLS IN TILBURY FIELD

Total Producing Wells	166
Equipped with pumps and syphons	91—or 55 per cent.
Requiring Pumping Equipment	23—or 14 per cent.
Showing Moisture	7—or 4 per cent.

This shows that 121 wells out of 166, or 73 per cent., were under treatment for water.

These conditions apply approximately to the wells operated by other companies in the same locality, and in dealing with the gas problem this water menace must never be disregarded nor neglected. A reference to the history of what is known as the Essex gas field[2] will demonstrate clearly that unless precautionary measures are taken to prevent the remaining gas content of the Tilbury field being drawn from the rock too rapidly, there is every reason to expect it will suffer a similar fate to that which befel the Essex field, which though only about five square miles in area, produced abundantly for about twelve years, after which the pressures decreased suddenly, and the field became exhausted three years later. That the water-flow in a gas well is controlled largely by the pressure maintained in the well, also by rate of flow at which gas is withdrawn, is shown by the chart on page 22, which records the water-pumping operations of two gas companies in adjacent localities in the Tilbury field.

It will be noted that the record is based upon the average number of gallons of water pumped per well per day.

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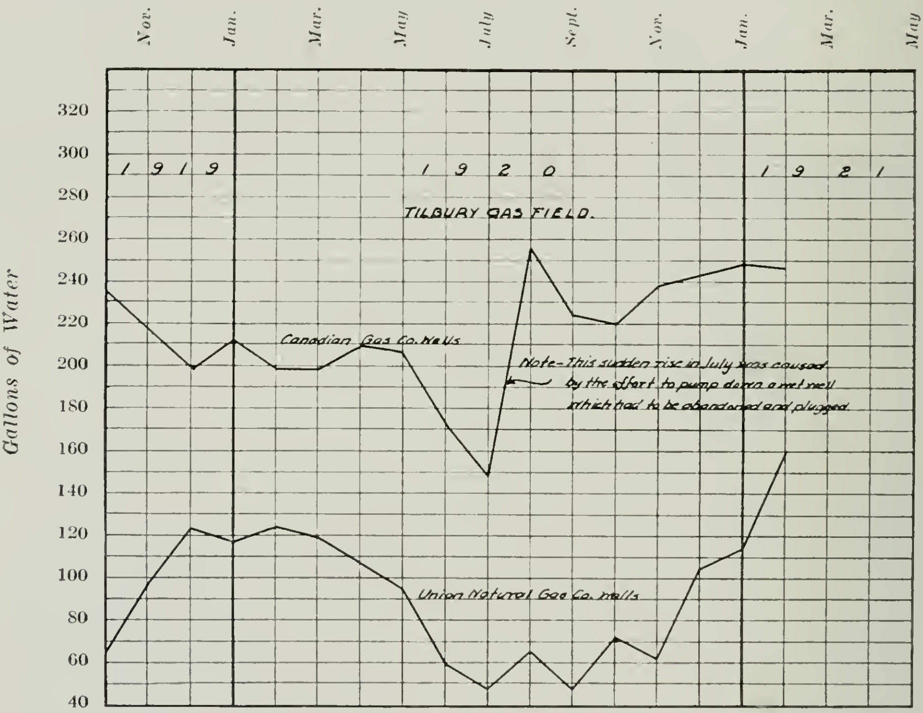
[1] The average yearly pressures of a prominent gas field in Alberta demonstrate that the depletion of gas fields is not confined to Ontario alone.

Year	1912	1913	1914	1915	1916	1917	1918	1919
Lbs.	744	723	660	641	629	446	312	251

[2] Ontario Bureau Mines, Vol. XXVIII, 1919, Pt. 1, p. 214.

The lower curve indicates that the water production during the months of September, October, November and December, 1919, and the same months of 1920, showed about the same range of variation; also that during the two cold months of January and February, 1920, it remained about even, then dropped quite suddenly, gradually increasing until it took a sudden rise, consistent with the increasing cold weather during November, December, and January, 1921. The general trend of the curve indicates that during the colder months of the year, when the pull is greater upon the output of the wells and pressures are low, the water-flow is heavy, and that in warm months, when consumption is at a minimum and pressure consequently at a maximum, the quantity of water is negligible. The sudden rise in June and July in the upper curve of the chart is explained by the fact that the wells in this field were under special treatment for water, and the condition of one well, which was flooded, and could not be pumped out, is indicated on the curve. This well was abandoned and plugged, otherwise the trend of the two curves is very similar.



Note—This sudden rise in July was caused by the effort to pump down a wet well which had to be abandoned and plugged.

Chart illustrating effect of water pumping by two gas companies in the Tilbury field.

The present cost of equipping a gas well with a gas-power water pumping unit is approximately as follows:

Unit Pumping Outfit	$ 621.00
Tubing, Rods, etc.	684.00
Shed, Foundation and Labor	150.00
Total	$1,455.00

The foregoing remarks have dealt largely with removing water from wells, but special attention has been given by the Department to "malignant wells;" the finding of those abandoned years ago and lost; the detecting of defective casing and the proper plugging of all kinds of abandoned wells. So many conditions exist whereby production from gas wells and fields is seriously retarded and diminished by the unrestrained flow of water from well to well, that the full importance of these defects, (as shown in illustrations 1 to 10) can hardly be over-estimated. On receipt of a complaint of water-damage or the intended plugging of an abandoned well, a competent inspector is immediately put in touch with the case, and the matter investigated and remedied under his supervision.

The following illustrations (Figures 1 to 10) are reproduced through the courtesy of the State Oil and Gas Supervisor of California. They are useful as showing what is required in dealing with typical cases. There are many other complications due to geological and mechanical conditions that could be illustrated, but these are sufficient to demonstrate the possibilities of damage due to neglected defects.

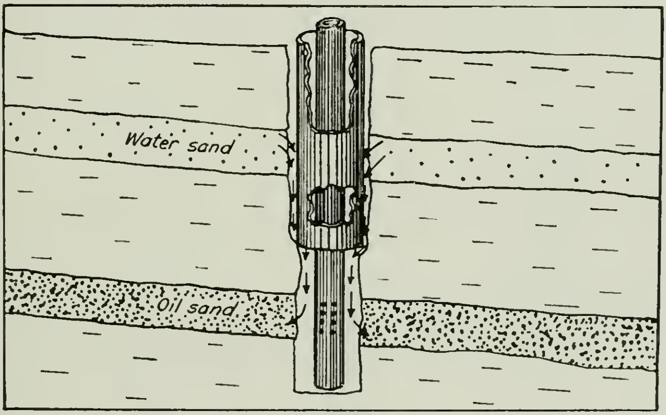


Fig. 1. Sketch showing entrance of water into oil sand due to imperfect seating of casing, and to lack of cement around bottom of outer casing.

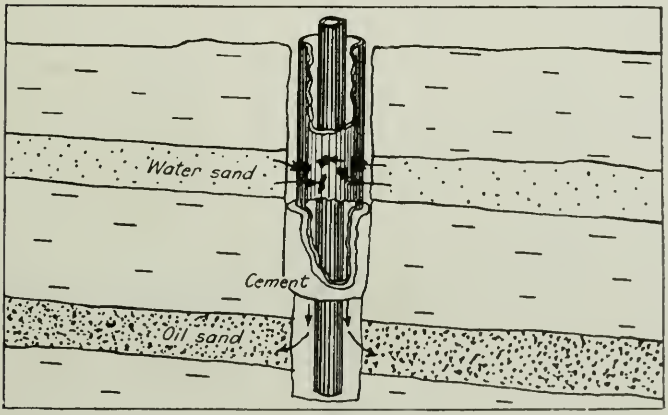


Fig. 2. Sketch showing entrance of water due to holes eaten in casing by chemical action.

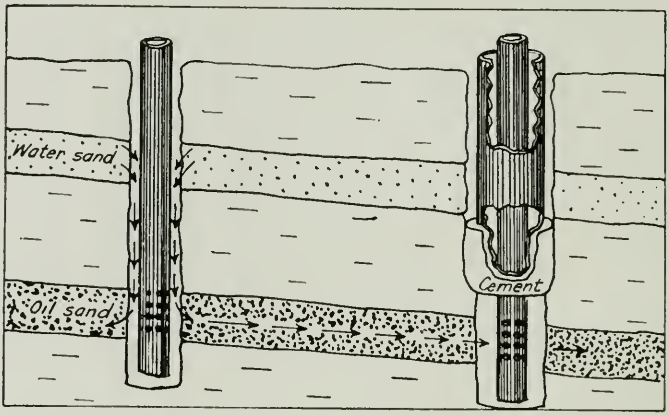


Fig. 3. Sketch showing entrance of water into oil sand and its migration to a properly drilled well due to use of only one string of casing in first well.

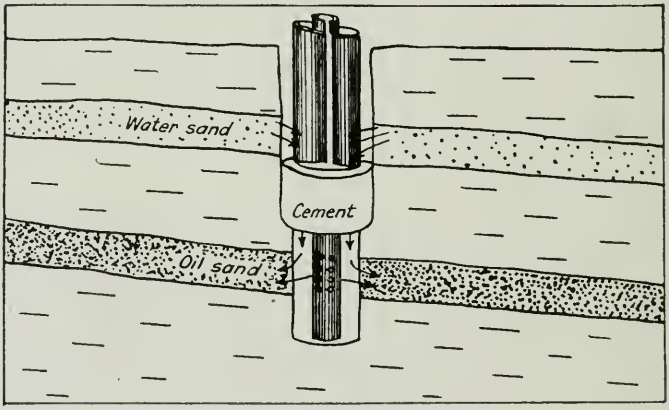


Fig. 4. Sketch showing entrance of water into oil sand due to collapse of casing.

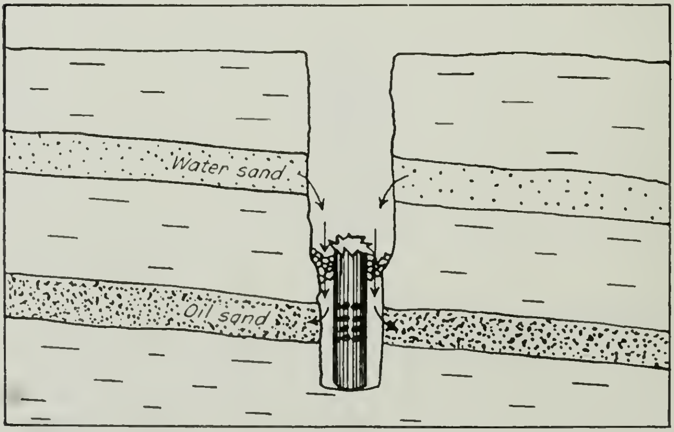


Fig. 5. Sketch showing entrance of water into oil sand due to withdrawal of casing from an abandoned well without placing a plug between oil and water sands.

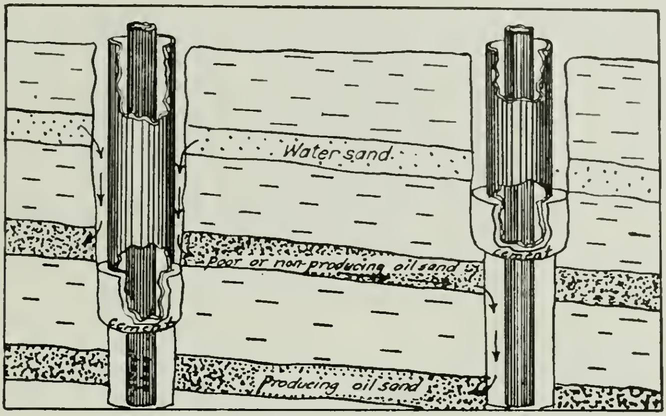


Fig. 6. Sketch showing entrance of water due to lack of uniformity of shut-off below water sands when two wells penetrated the same strata. If there were only one well, either one would probably be in good condition.

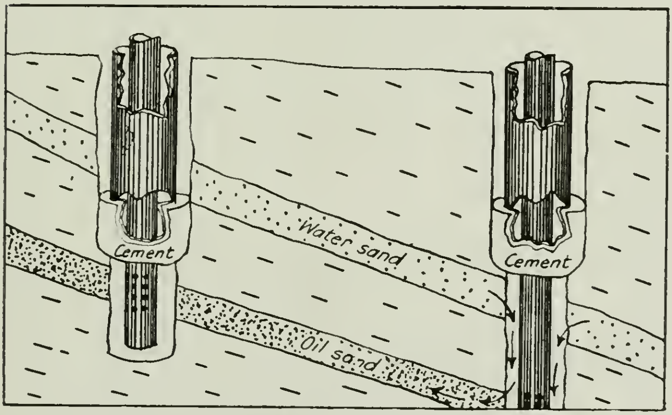


Fig. 7. Sketch showing entrance of water due to fact that shut-off was made at the same depth in two wells without considering the geological fact that strata most frequently do not lie parallel to ground surface.

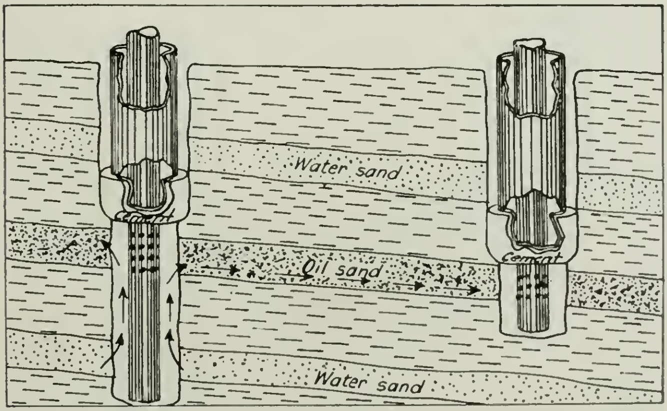


Fig. 8. Sketch showing entrance of water into a properly drilled well due to the fact that another well drilled into a water bearing sand below the oil sand, but did not plug the lower portion of the well.

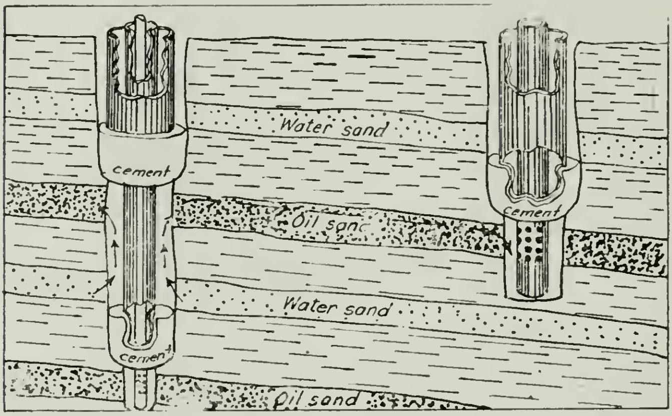


Fig. 9. Sketch showing entrance of water into a properly drilled well because a neighbouring well entered a deeper oil sand without an extra string of casing being inserted to protect the first sand.

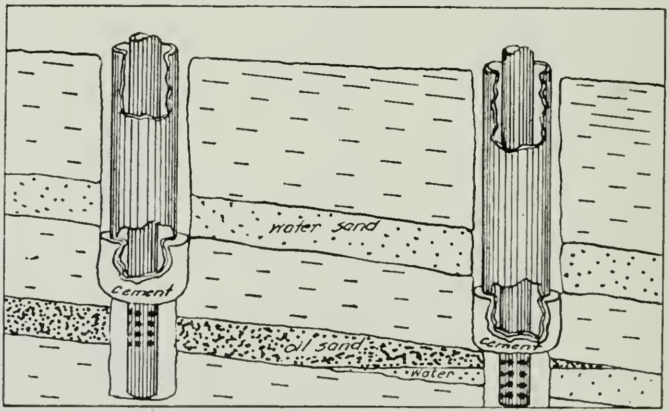
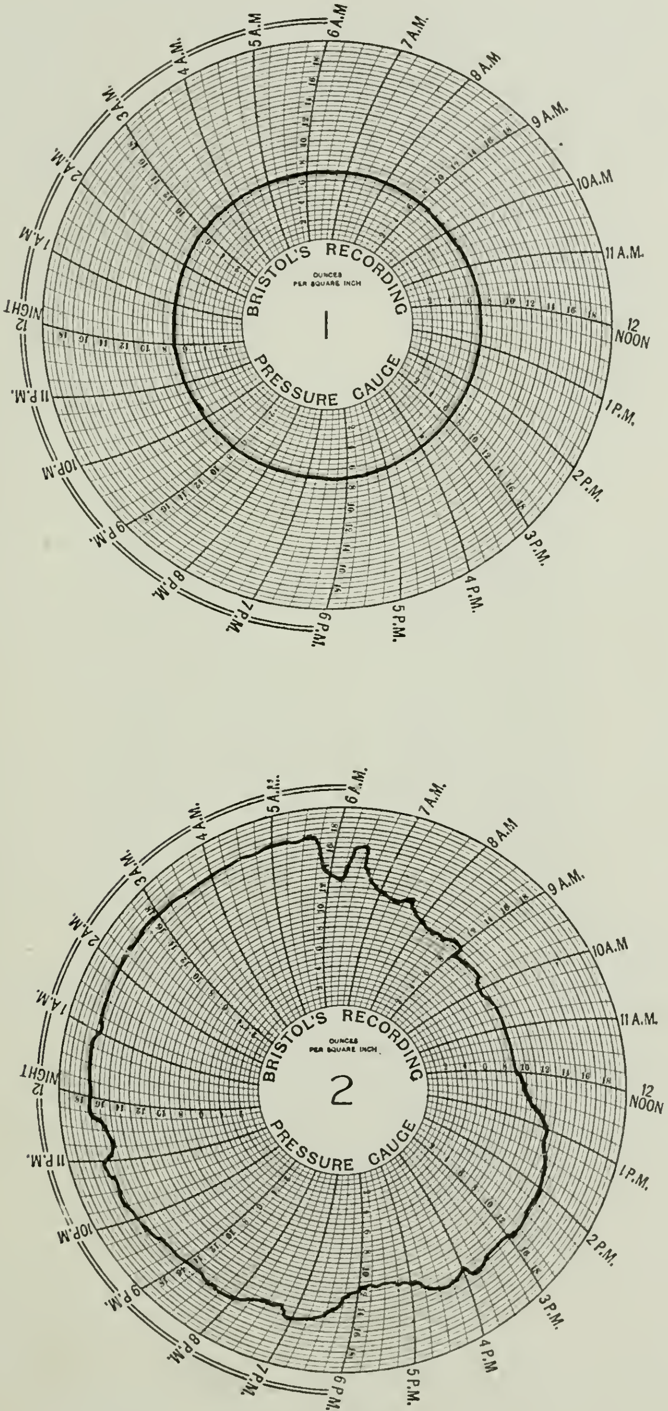


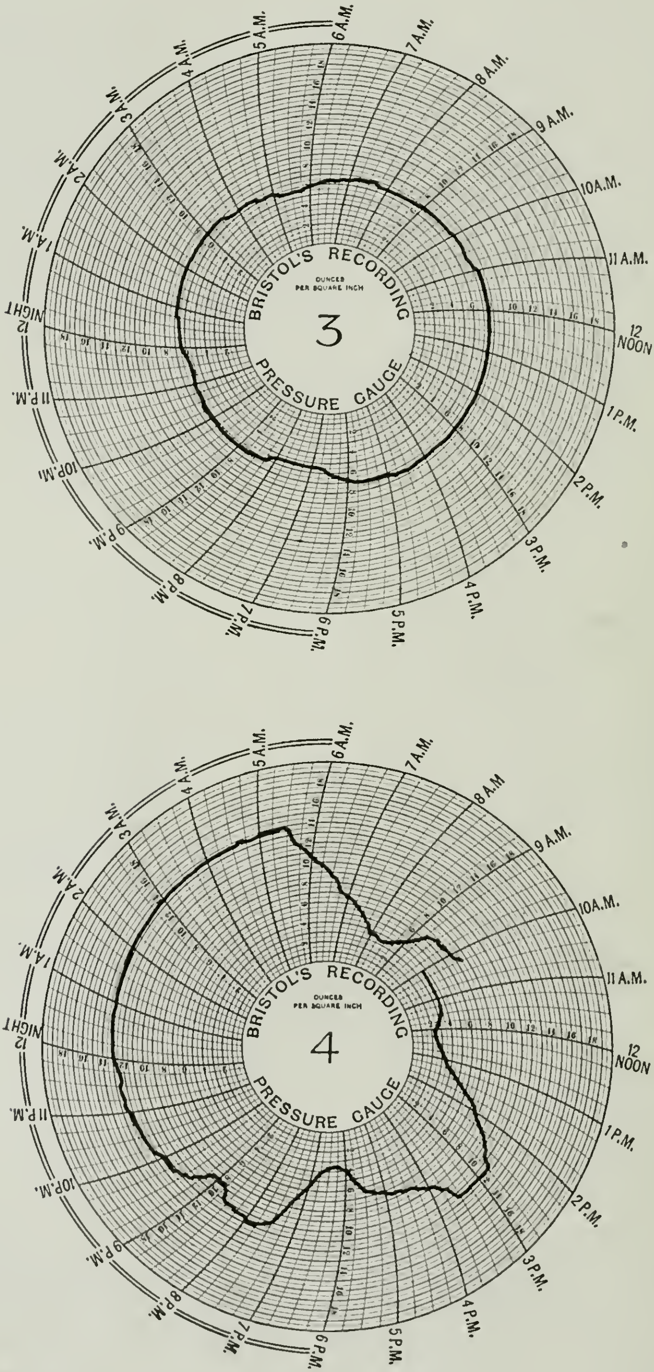
Fig. 10. Sketch showing presence of edge water due to a natural condition. Most oil sands when followed far enough down the dip are found to contain only water. As oil is removed from above, water follows it up along the stratum.

Distribution Problems

The problems connected with the distribution of the product of the Ontario gas fields are very confusing to that portion of the population who are consumers of this valuable fuel. It is difficult, for instance, to understand why a shortage, causing general inconvenience and discomfort, should ever occur when, for nearly nine months out of the year, there is ample gas for everyone and for all purposes. The "peak demand" can be more easily understood by referring to chart on page 6, which shows how the consumption rises to the highest levels in the coldest months. This only gives a general idea of the situation, because the real "peak demand" coming on cold days, the sudden pull upon all the supply lines, occurring at once, is far greater than the delivery from the wells: the result is the partial emptying of pipelines and reduction of pressure. The daily and hourly "peak" is the real terror of all gas distributors and producers.



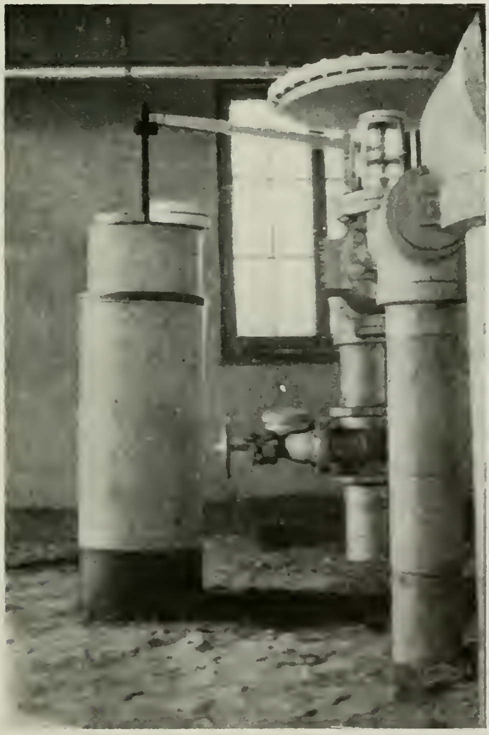
Pressure Charts No's 1 and 2.



Pressure Charts No's 3 and 4,

Pressure Chart No. 2 was taken from a recording pressure gauge before the gasometer attachment was installed and Pressure Chart No. 1 shows the reading after the installation. Pressure charts 4 and 3 were both taken from another regulator, before and after the installation of a gasometer respectively, and show similar results. This is an important innovation, and a very welcome addition to the distributing equipment because by the use of the gasometer attachment, great improvement is effected in the service to the consumer, who receives a more even pressure.

Many of the troubles caused by the effort to distribute natural gas under varying pressures are very real, and occasion the gas operator considerable concern. Frequent changes of pressure occurring in the distribution of Tilbury gas throw a heavy responsibility upon the regulators. These instruments are affected by the corrosive elements in the gas, and require constant attention. The Department has watched with interest the installation of a gasometer attachment, recently applied to low pressure regulators.



Gasometer attachment to low pressure regulator.

Field Operations

Ninety-four wells were drilled in 1920, most of them in the counties of Haldimond, Welland, Norfolk and Kent. Of these new wells, 73 were producers, and 21 or 22.3 per cent., were non-producers The 73 producers showed a total open-flow measurement of 9,203,000 cubic feet. Following is a list of the new wells and the individuals or companies for whom they were sunk.

GAS WELLS DRILLED IN 1920

Owner	Locality				Gas or Oil	Production per day,[1] Cubic Feet	Date Completed
	Lot, Concession		Township	County			
Richmond Gas Co.	1	4	Bayham	Elgin	Gas	300,000	Aug. 16th
Dominion Natural Gas Co......	120	7	Bayham	Elgin	"	Dry	May 10th
"	18	2	"	"	"	39,000	Dec. 14th
Glenwood Natural Gas Co....	21	8	Aldboro	"	"	Dry	Jan. 12th
Glenwood Natural Gas Co....	14	1	Mersea	Essex	"	Dry	June 21st
Dominion Natural Gas Co...	Dochstader Farm		Canboro	Haldimand	"	46,000	March 24th
"	C. Kuren Farm		"	"	"	21,000	June 9th
Oswego Gas Co.....	5	1	"	"	"	32,000	July 17th
Dominion Natural Gas Co....	P. Kuren Farm		"	"	"	64,000	July 6th
"	W. Clifford Farm		"	"	"	70,000	July 28th
"	W. Clifford Farm		"	"	"	75,000	Aug. 13th
"	W. Crumb Farm		"	"	"	45,000	Sept. 1st
"	W. Crumb Farm		"	"	"	68,000	Nov. 19th
"	E. Crumb Farm		"	"	"	67,000	Sept. 24th
Dominion Natural Gas Co....	S. Crosby Farm		Canboro	Haldimand	"	157,000	Oct. 12th
"	S. Crosby Farm		"	"	"	105,000	Oct. 29th
"	4	3	"	"	"	Dry	Dec. 7th
"	8	3	"	"	"	97,000	Dec. 30th
Lalor, F. R...	7	1	Moulton	"	"	Est. 80,000	July 27th
Lalor, F. R...	7	1	"	"	"	" 70,000	Sept. 13th
Maple Leaf Oil & Gas Co.	15	2	"	"	"	25,000	May 15th
"	13	3	"	"	"	200,000	July 30th
"	13	3	"	"	"	175,000	Sept. 9th
"	9	3	"	"	"	250,000	Oct. 20th
"	10	2	"	"	"	200,000	Dec. 21st
Midfield Gas Co......	53	1	North Cayuga	"	"	6,000	Feb. 9th
"	53	1	"	"	"	80,000	Mar. 25th
Oswego Gas Co......	5	Stage Road	"	"	"	156,000	Aug. 20th
"	4	"	"	"	"	97,000	Sept. 23rd
Azoff Gas Co.	3	3	"	"	"	39,000	Nov. 18th
"	1	1	"	"	"	Dry	Dec. 31st

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[1] It should be noted that the volume of gas given here is "open flow" and not the actual quantity of serviceable gas "in the line."

GAS WELLS DRILLED IN 1920.—*Continued*

Owner	Locality				Gas or Oil	Production per day, Cubic Feet	Date Completed
	Lot.	Concession	Township	County			
United Gas Companies...	4	1	North Cayuga	Haldimand	Gas	585,000	July 15th
“	4	1	“	“	“	382,000	Aug. 4th
“	4	1	“	“	“	Dry	Oct. 27th
“	4	1	“	“	“	78,000	Nov. 17th
Midfield Gas Co......	53	1	Oneida	“	“	74,000	May 7th
“	54	Town Line	“	“	“	75,000	June 26th
“	53	1	“	“	“	50,000	Aug. 11th
Dominion Natural Gas Co..........	61	4	Oneida	“	“	111,000	Oct. 13th
“	68	River Road	“	“	“	85,000	Dec. 4th.
“	65	“	“	“	“	171,000	Dec. 13th
Sterling Natural Gas Co..........	17	1	Sherbrooke	“	“	200,000	Mar. 26th
“	17	1	“	“	“	Dry	May 31st
United Gas Companies...	3	1	Seneca	“	“	231,000	Sept. 21st
“	3	1	“	“	“	45,000	Oct. 6th
Dominion Natural Gas Co..........	F. Langford Farm		“	“	“	21,000	Jan. 10th
“	B.	2	“	“	“	34,000	Jan. 24th
“	R. Young Farm		“	“	“	Dry	Apr. 2nd
“	N. Kelly Farm		“	“	“	87,000	Aug. 21st
“	N. Kelly Farm		“	“	“	75,000	Apl. 4th
“	Shipway Farm		“	“	“	110,000	Dec. 17th
Port Colborne -Welland Gas Co..........	S. Bradt Farm		“	“	“	87,000	Oct. 11th
“	B. Hanna Farm		“	“	“	367,000	Dec. 4th
Petrol Oil & Gas Co......	1	Front	Dover	Kent	“	Est. 500,000	May 25th
“	1	“	“	“	“	Dry	Dec. 4th
B. Jasperson.	15	13	East Tilbury	“	“	70,000	Mar. 17th
Glenwood Natural Gas Co..........	13	Middle Road	“	“	“	700,000	May 15th
“	13	“	“	“	“	225,000	Aug. 11th
“	14	“	“	“	“	Dry	Oct. 28th
Glenwood Natural Gas Co..........	3	1	Raleigh	“	“	45,000	Dec. 31st
“	191	Talbot Road	Romney	“	“	Dry	Mar. 13th
“	25	2	“	“	“	Dry	Aug. 16th
B. Jasperson.	28	2	“	“	“	80,000	Nov. 19th
Chippewa Oil & Gas Co....	3	3	Caistor	Lincoln	“	97,000	Jan. 7th
Castle Oil & Gas Co......	25	5	Euphemia	Lambton	“	Est. 80,000	Mar. 2nd
“	27	5	“	“	“	Dry	July 6th
“	27	5	“	“	“	Dry	July 7th

GAS WELLS DRILLED IN 1920.—*Continued*

Owner	Locality				Gas or Oil	Production per day, Cubic Feet	Date Completed
	Lot, Concession		Township	County			
Progressive Natural Gas Co.......	4	3	North Dorchester	Middlesex	Gas	Dry	May 14th
“	4	3	“	“	“	“	June 23rd
“	4	3	“	“	“	250,000	Dec. 14th
Dominion Natural Gas Co..........	Long Point		N. Walsingham	Norfolk	“	150,000	Mar. 6th
“	6	Front	Woodhouse	“	“	252,000	May 20th
“	35	3	Middleton	“	“	42,000	June 2nd
“	4	3	Houghton	“	“	90,000	July 10th
Dominion Natural Gas Co.........	43	2	Middleton	Norfolk	“	131,000	July 22nd
“	4	N. Talbot Road	“	“	“	Dry	Nov. 29th
“	6	Front	Woodhouse	“	“	140,000	July 31st
“	Niagara & Erie Land Co.		North Walsingham	“	“	68,000	Aug. 19th
“	“		“	“	“	80,000	Sept. 3rd
“	“		“	“	“	39,000	Oct. 21st
“	A. Keable Farm		“	“	“	Dry	Nov. 22nd
“	21	14	“	“	“	83,000	Dec. 11th
“	5	Front	Woodhouse	“	“	37,000	Oct. 2nd
“	6	“	“	“	“	42,000	Dec. 7th
Dominion Natural Gas Co..........	2	4	Binbrook	Wentworth	“	40,000	Oct. 30th
“	1	1	“	“	“	90,000	Dec. 23rd
Sparham, A.F	11	8	Glanford	“	“	Est. 50,000	Dec. 22nd
Provinc'l Natural Gas Co.	26	2	Bertie	Welland	“	40,000	June 21st
“	10	2	“	“	“	Dry	May 11th
“	10	5	“	“	“	Est. 85,000	June 25th
“	11	13	“	“	“	40,000	Aug. 15th
“	8	13	“	“	“	225,000	Oct. 21st
“	9	13	“	“	“	Dry	Nov. 15th
“	11	5	Willoughby	“	“	Dry	Dec. 16th

SUMMARY OF NEW WELLS.

	No.
Elgin County...................................	4
Essex County...................................	1
Haldimand County...............................	48
Kent County....................................	10
Lincoln County.................................	1
Lambton County.................................	3
Middlesex County...............................	3
Norfolk..	14
Wentworth County...............................	3
Welland County.................................	7
Total..	94

The number of wells drilled in 1920 was up to the average of the two previous years, but much less than the average for 1916 and 1917. The quantity of new gas brought in was considerably less than in 1919. As compared with last year's operations, there is a falling off indicated in the amount of gas recovered as shown by the following table:—

TABLE XI. —DRILLING OPERATIONS FOR FIVE YEARS

YEAR	NEW WELLS	PRODUCERS	NON-PRODUCERS		DAILY OPEN-FLOW PRODUCTION, CU. FT.
			NUMBER	PER CENT	
1916	173	135	38 or	22.0	....
1917	173	121	52 or	30.0	....
1918	97	66	31 or	32.0	....
1919	93	77	16 or	17.2	20,000,000
1920	94	73	21 or	22.3	9,203,000

It is safe to assume that, as most of the drilling was done in the older gas territory, the results could hardly be expected to show a gain over the previous year. When more active drilling operations are carried on in new or "wild cat" districts, the productivity of each new well should make a very much more encouraging showing.

The drilling of new wells is the most important part of the gas enterprise; without a persistent and courageous policy of development, no gas field can be made to survive. The drill must be kept active if new gas is to be obtained to replace that drawn from the fields from year to year. This means that sufficient money must be derived from the sale of gas to take care of this work in the face of 22.3 per cent. "dry holes." These comparisons show clearly that the natural gas rates have a direct bearing upon the kind of service the public may expect if development work is not encouraged.

The importance of caring for the "dead" wells has been referred to elsewhere in this report. These operations for the year included the plugging of 45 old wells and the 21 new non-producers reported as new drilling.

Drillers' Logs

The following "drillers' logs" are reproduced here because it is found that such logs are useful to those engaged in active field operations, and are readily understood by the field men themselves, who also can have access to the printed reports without being obliged to resort to office records merely.

Since taking charge of natural gas affairs, the Ontario Department of Mines has collected and recorded in the Gas Commissioner's office about 200 well logs. As a large portion of the information from which the early geological data was compiled had to be obtained from a few recorded logs and from the memory of those who did the actual drilling, these records being recent in date and made while fresh in the minds of the drillers, are bound to have considerable value in studying the stratigrophy of known or possible gas areas.

It would have a very direct bearing on the development of the known gas fields and the location of further supplies of gas either in areas as yet unrecognized, or in more deeply seated rock formations, if greater attention could be paid to the investigation of the structural and stratigraphical geology of south-western Ontario.

It is to be hoped that the Ontario Department of Mines may make provision for this work at an early date, and arrange to obtain the required data direct. This is the only way that reliable logs of all borings can be obtained. The progress of each drill-hole must be watched from day to day and measurements and cuttings obtained by an official who will have access to all borings during their progress. The close study of the formations favorable to deposits of gas and petroleum and the preparation of carefully prepared reference maps showing the levels, contours and other structural details, are of the highest importance and value to the development of all the gas and petroleum resources of the Province. The same careful attention could at the same time be given to the conditions affecting other resources such as salt, gypsum, water supplies, etc. Such information properly worked up and tabulated would enable the development of further gas supplies to proceed with a minimum of risk.

Log No. 1.

Lot.	Concession.	Township.	County.
13	Middle road South	Tilbury East.	Kent.

Estimated Production 700,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Clay	145 ft.	145 ft.
Limestone	20	165
Lime	10	175
Grey Lime	125	300
Dark Grey Lime	290	590
Grey Sharp Sand	45	635
Grey Lime	75	710
Light Grey Lime	90	800
First Gas	390	1190
Slate	40	1230
Grey Lime	120	1350
Gas		
Total Depth	1350 feet	

Log No 2.

Lot.	Concession.	Township.	County.
191	Talbot road.	Romney.	Kent.

Dry Hole; Plugged.

Formation	Thickness of Formation	Total Depth
Clay	160 ft.	160 ft.
Gravel	15	175
Lime	25	200
Gravel and Soap	50	250
Grey Lime	240	490
Sharp Sand	70	560
Grey Lime	190	750
Slate	190	940
Lime	310	1250
Showing of Gas	20	1270
Gas Sand	50	1320
Lime	40	1360
Salt Sand	140	1500
Red Medina	30	1530
White Medina	80	1610
Total Depth	1610 feet	

Log No 3.

Lot.	Concession.	Township.	County.
13	Middle Road South	Tilbury East.	Kent

Estimated Production, 225,000 cubic feet

Formation	Thickness of Formation	Total Depth
Clay	105 ft.	105 ft.
Sand & Gravel	40	145
Soap Stone	65	210
Grey Lime	260	470
Sharp Sand	170	640
Grey Lime	410	1050
Slate	130	1180
Grey Lime	185	1365
Total Depth	1365 feet	

Log No 4.

Lot.	Concession.	Township.	County.
Long Point Company.		South Walsingham	Norfolk.

Estimated Production 150,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Grey Medina		190 ft.
Flint		348
Lime		545
Niagara		990
Slate		1225
Red Medina		1360
White Medina		1467
Red Shale		1482
Total Depth	1482 feet	

Log No 5.

Lot.	Concession.	Township.	County.
4	III.	Houghton	Norfolk.

Estimated Production 314,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface	294 ft.	294 ft.
Brown Lime	206	500
Flint	150	650
White Lime	450	1100
Niagara	235	1335
Slate	69	1404
Clinton	20	1424
Red Medina	15	1439
White Medina	24	1463
Total Depth	1463 feet	

Log No 6.

Lot.	Concession.	Township.	County
35	III.	Middleton	Norfolk.

Estimated Production 42,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface	218 ft.	218 ft.
Lime	151	369
Flint	48	417
Sharp Sand	80	497
Hard Lime	50	547
Lime & Shale	81	628
Brown Lime	98	726
Hard Lime	148	874
Niagara Lime	243	1117
Shale	43	1160
Clinton	30	1190
Red Medina	5	1195
Grey Shale	35	1230
Total Depth	1230 feet	

Log No 7.

Lot.	Concession.	Township.	County.
43	II.	Middleton	Norfolk.

Estimated Production 131,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface		184 ft.
Lime		315
Flint		380
Sharp Sand		435
Hard Lime		493
Lime & Shale		601
Brown Lime		696
Hard Lime		840
Niagara Lime		1100
Shale		1108
Climton		1135
Red Medina		1140
Shale		1177
Total Depth	1177 Feet	

Log No 8.

Lot.	Concession.	Township.	County.
Niagara & Erie Land Co.		N. Walsingham	Norfolk.

Estimated Production 80,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Lime		219 ft.
Hard Lime		498
Lime & Shale		548
Niagara Lime		873
Red Medina		1195
Grey Shale		1200
Total Depth	1200 Feet	

Log No 9.

Lot.	Concession.	Township.	County.
Niagara & erie Land Co		N. Walsingham	Norfolk.

Estimated Production 68,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Lime		202 ft.
Hard Lime		492
Lime & Shale		543
Niagara Lime		870
Red Medina		1193
Grey Shale		1198
Total Depth	1198 Feet	

Log No 10.

Lot.	Concession.	Township.	County.
5	Broken Front	Woodhouse	Norfolk·

Estimated Production 37,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Flint		129 ft.
Lime & Shale		375
Niagara Lime		674
Shale		960
Red Medina		1040
White Medina		1145
Red Shale		1151
Total Depth	1151 Feet.	

Log No 11.

Lot.	Concession.	Township.	County.
Peter Boughner farm.		Woodhouse	Norfolk.

Estimated Production 252,00 cubic feet.

Formation	Thickness of Formation	Total Depth
Flint		117 ft.
Lime & Shale		375
Niagara Lime		670
Shale		964
Red Medina		1036
White Medina		1132
Red Shale		1152
Total Depth	1152 Feet.	

LOG NO 12.

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
PETER BOUGHNER FARM		WOODHOUSE	NORFOLK

Estimated Propuction 140,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Flint		95
Lime & Shale		342
Niagara Lime		642
Clinton		990
Red Medina		1018
White Medina		1113
Red Shale		1133
Total Depth	1133 Feet.	

LOG NO 13.

LOT.	CONCESSION.	TOWNSHIP.	COUNTY,
14	I.	MERSEA	ESSEX

Dry Hole. Plugged.

Formation	Thickness of Formation	Total Depth
Clay	82 ft.	
Clay & Gravel	70	152 ft.
Lime	18	170
Lime Grey	50	220
Lime Brown	70	290
Lime Grey	70	360
Lime Light Grey	65	425
Lime Dark Grey	50	475
Lime Light Brown	50	525
Lime Dark Grey	117	642
Lime Brown	18	660
Lime Grey	50	710
Lime Dark Grey	60	770
Slate	230	1000
Total Depth	1000 Feet.	

LOG NO 14.

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
13	III.	MOULTON	HALDIMAND.

Estimated Production 150,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface	100 ft.	
Brown Lime	125	225 ft.
Niagara	210	435
Casing Shale	50	485
Clinton	30	515
Red Medina	40	555
Blue Shale	60	615
White Medina	10	625
Red Shale	50	675
Total Depth	675 Feet.	

LOG NO. 15.

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
15	II.	MOULTON	HALDIMAND.

Estimated Production, 25,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface	94 ft.	
Brown Lime	140	234 ft.
Niagara	201	435
Casing Shale	40	475
Clinton	30	505
Red Medina	40	545
Blue Shale	60	605
White Medina	12	617
Red Shale	110	727
Total Depth	727 Feet.	

LOG NO. 16

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
13	III.	MOULTON	HALDIMAND.

Estimated Production, 200,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface	110 ft.	
Brown Lime	120	230 ft.
Niagara	200	430
Casing Shale	55	485
Clinton	28	513
Red Medina	42	555
Blue Shale	63	618
White Medina	12	630
Red Shale	53	683
Total Depth	683 Feet.	

LOG NO. 17.

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
9	III.	MOULTON	HALDIMAND.

Estimated Productions, 250,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface	91 ft.	
Lime	130	221 ft.
Niagara	214	435
Casing Shale	52	487
Clinton	35	522
Red Medina	40	562
Blue Shale	58	620
White Medina	12	632
Red Shale	50	682
Total Depth	682 Feet.	

Log No. 18.

Lot.	Concession.	Township.	County.
10	II.	Moulton	Haldimand.

Estimated Productions, 200,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface	91 ft.	
Lime	132	223 ft.
Niagara	205	428
Casing Shale	60	488
Clinton	35	523
Red Medina	35	558
Blue Shale	54	612
White Medina	15	627
Red Shale	55	682
Total Depth	682 Feet.	

Log No. 19.

Lot.	Concession.	Township.	County.
S½ 54	Town Line road	Oneida	Haldimand

Estimated Productions, 75,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Clay	10 ft.	
Flint	21	31 ft.
Grey Lime	61	92
Shale	88	180
Shale & Limestone	127	407
Guelph Lime	100	280
Niagara Limestone	249	656
Casing Shale	15	671
Grey Shale	48	719
Clinton Sand No. 1	26	745
Red Medina Sand No. 2	43	788
Blue Shale	50	838
White Medina Sand No. 3	10	848
Red Shale	29	877
Total Depth	877 Feet.	

Log No. 20.

Lot.	Concession.	Township.	County.
S½ 54	Stage road	N. Cayuga	Haldimand

Estimated Productions, 97,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface	43 ft.	
Shale	152	195 ft.
Niagara	200	395
White Lime	55	450
Shale	32	482
Clinton	28	510
Red Medina	38	548
Blue Shale	59	607
White Medina	15	622
Red Shale	28	650
Total Depth	650 Feet.	

Log No. 21.

Lot.	Concession.	Township.	County.
N½ 53	I.	Oneida	Haldimand

Estimated Production, 50,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Clay	7 ft.	
Shelly, Rock & Flint	25	32 ft.
Grey Lime	48	80
Shale	105	185
Guelph Lime	90	275
Shale & Limestone	125	400
Niagara Lime	246	646
Casing Shale	44	690
Shale	7	697
Clinton Sand No. 1	30	727
Red Medina Sand No. 2	42	769
Blue Shale	41	810
White Medina No. 3	12	822
Red Shale	40	862
Total Depth	862 Feet.	

Log No. 22.

Lot.	Concession.	Township.	County.
3		N. Cayuga	Haldimand.

Estimated Production, 39,400 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface	38	
Shale	142	180 ft.
Niagara	200	380
White Lime	51	431
Shale	34	465
Clinton	29	494
Red Medina	35	529
Blue Shale	60	589
White Medina	13	602
Red Shale	2	604
Total Depth	604 Feet.	

Log No. 23.

Lot.	Concession.	Township.	County.
1		N. Cayuga	Haldimand.

Dry Hole; Plugged.

Formation	Thickness of Formation	Total Depth
Surface	47	
Shale	138	185 ft.
Niagara	200	385
White Lime	50	435
Shale	30	465
Clinton	25	490
Red Medina	37	527
Blue Shale	61	588
White Medina	13	601
Red Shale	4	605
Total Depth	605 Feet.	

Log No. 24.

Lot.	Concession.	Township.	County.
61	IV.	Oneida	Haldimand.

Estimated Production 111,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Clay	67	
Shale & Limestone	168	235 ft.
Niagara Lime	227	462
Casing Shale	9	471
Grey Shale	39	510
Clinton Sand No. 1	25	535
Red Medina No. 2	44	579
Blue Shale	50	629
White Medina Sand No. 3	18	647
Red Shale	50	697
Total Depth	697 Feet.	

Log No. 25.

Lot.	Concession.	Township.	County.
68	River Range	Oneida	Haldimand

Estimated Production 85,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Clay or Surface	18	
Gypsum & Shale	21	39 ft.
Shale & Limestone	182	221
Niagara Lime	229	450
Casing Shale	10	460
Grey Shale	37	497
Clinton Sand No. 1	31	528
Red Medina Sand No. 2	46	574
Blue Shale	45	619
White Medina Sand No. 3	16	635
Red Shale	50	685
Total Depth	685 Feet.	

Log No. 26.

Lot.	Concession.	Township.	County.
65	River Range	Oneida	Haldimand.

Estimated Production 171,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface Clay	25	
Guelph Lime & Shale	194	219 ft.
Niagara Lime	211	430
Casing Shale	17	447
Grey Shale	36	483
Clinton Sand No. 1	22	505
Red Medina No. 2	46	551
Blue Shale	46	597
White Medina Sand No.3	23	620
Red Shale	50	670
Total Depth	670 Feet.	

Log No. 27.

Lot.	Concession.	Township.	County.
S½ 53	I.	Oneida	Haldimand.

Mercury Guage Reading 74,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Clay	11	
Flint	18	29 ft.
Grey Lime	61	90
Shale	95	185
Guelph Lime	100	285
Shale & Limestone	124	409
Niagara Limestone	235	644
Casing Shale	21	665
Grey Shale	41	706
Clinton Sand	36	742
Red Medina Sand	35	777
Blue Shale	45	822
White Medina	12	834
Red Shale	42	876
Total Depth	876 Feet.	

Log No. 28.

Lot.	Concession.	Townnship.	County.
17	I.	Sherbrooke	Haldimand.

Estimated Production 200,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface	25	
Shale & Lime	485	510 ft.
Niagara	235	745
Shale	55	800
Clinton	30	830
Red Medina	45	875
Shale	52	927
White Medina	15	942
Red Shale	40	982
Total Depth	982 Feet.	

Log No. 29.

Lot.	Concession.	Township.	County.
17	I.	Sherbrooke	Haldimand

Dry Hole; Plugged.

Formation	Thickness of Formation	Total Depth
Surface	49	
Flint	85	134 ft.
Shale	81	215
Brown Lime	75	290
Shale & Lime	210	500
Niagara	180	680
Shale	55	735
Clinton Rock	30	765
Red Medina	40	805
Grey Shale	60	865
White Medina	17	882
Total Depth	882 Feet.	

LOG NO. 30

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
53	I.	N. CAYUGA	HALDIMAND.

Estimated Production, 6,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Clay	7	
Flint	38	45 ft.
Grey Lime	45	90
Shale	95	185
Guelph Lime	100	285
Shale & Limestone	147	432
Niagara	231	663
Grey Shale	61	724
Clinton Sand	27	751
Red Medina Sand	48	799
Blue Shale	50	849
White Medina Sand	15	864
Red Shale	30	894
Total Depth	894 Feet.	

LOG NO. 31.

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
53	I.	N. CAYUGA	HALDIMAND.

Formation	Thickness of Formation	Total Depth
Clay	15	
Flint	24	39 ft.
Grey Lime	51	90
Shale	95	185
Guelph Lime	108	293
Shale & Limestome	128	421
Niagara Lime	234	655
Casing Shale	54	709
Clinton Sand	28	737
Red Medina	48	785
Blue Shale	42	827
White Medina	14	841
Red Shale	46	887
Total Depth	887 Feet.	

LOG NO. 32.

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
FLORENCE LANGFORD FARM		SENECA	HALDIMAND

Estimated Production, 21,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Niagara		186
Red Medina		481
White Medina		562
Red Shale		584
Total Depth	584 Feet.	

Log No. 33.

Lot.	Concession.	Township.	County.
Robt. A. Young farm		Seneca	Haldimand.

Dry Hole; Plugged.

Formation	Thickness of Formation	Total Depth
Niagara		165
Red Medina		475
White Medina		571
Red Shale		584
Total Depth	584 Feet.	

Log No. 34.

Lot.	Concession.	Township.	County.
B	II.	Seneca	Haldimand.

Estimated Production, 34,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Niagara		115
Red Medina		444
White Medina		537
Red Shale		549
Total Depth	549 Feet.	

Log No. 35.

Lot.	Concession.	Township.	County.
5	I.	Canboro	Haldimand.

Estimated Production 32,320 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface	53	
Shale	142	195 ft.
Niagara	200	395
White Lime	50	445
Shale	28	473
Clinton	28	501
Red Medina	38	539
Blue Shale	59	598
White Medina	18	616
Red Shale	26	642
Total Depth	642 Feet.	

Log No. 36.

Lot.	Concession.	Township.	County.
5	Stage Road	N. Cayuga	Haldimand.

Estimated Production 156,830 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface	43	
Shale	150	193 ft.
Niagara	200	393
White Lime	55	448
Shale	35	483
Clinton	28	511
Red Medina	35	546
Blue Shale	60	606
White Medina	17	623
Red Shale	27	650
Total Depth	650 Feet.	

Log No. 37.

Lot.	Concession.	Township.	County.
Oliver Dochstader farm		Canboro	Haldimand

Formation	Thickness of Formation	Total Depth
Niagara		247
Shale		477
Red Medina		555
White Medina		642
Red Shale		667
Total Depth	667 Feet.	

Log No. 38.

Lot.	Concession.	Township.	County.
Chester VanKuren farm		Canboro	Haldimand.

Estimated Production 21,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Niagara		245
Slate		485
Red Medina		563
White Medina		653
Red Shale		675
Total Depth	675 Feet.	

Log No. 39

Lot.	Concession.	Township.	County.
PaulVanKuren farm		Canboro	Haldimand.

Estimated Production 64,000 cubic feet

Formation	Thickness of Formation	Total Depth
Niagara		245
Shale		485
Red Medina		563
White Medina		658
Red Shale		678
Total Depth	678 Feet	

Log No. 40.

Lot.	Concession.	Township.	County.
Wm. Clifford farm		Canorbo	Haldimand.

Estimated Production 70,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Niagara		246
Shale		486
Red Medina		569
White Medina		664
Red Shale		689
Total Depth	689 Feet.	

Log No. 41.

Lot.	Concession.	Township.	County.
Wm. Clifford farm		Canboro	Haldimand.

Estimated Production 75,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Niagara		246
Shale		486
Red Medina		563
White Medina		651
Red Shale		676
Total Depth	676 Feet.	

Log No. 42.

Lot.	Concession.	Township.	County.
Walter Crumb farm		Canboro	Haldimand.

Estimated Production 45,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Niagara		236
Shale		480
Red Medina		577
White Medina		649
Red Shale		673
Total Depth	673 Feet.	

Log No. 43.

Lot.	Concession.	Township.	County.
Walter Crumb farm		Canboro	Haldimand

Estimated Production 68,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Niagara		230
Shale		465
Red Medina		548
White Medina		638
Red Shale		653
Total Depth	653 Feet.	

Log No. 44.

Lot.	Concession.	Township.	County.
Elias Crumb farm		Canboro	Haldimand.

Estimated Production, 67,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Niagara		238
Shale		472
Red Medina		550
White Medina		635
Red Shale		657
Total Depth	657 Feet.	

Log No. 45.

Lot.	Concession.	Township.	County.
S. J. Crosby farm		Canboro	Haldimand.

Estimated Production, 157,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Niagara		225
Shale		470
Red Medina		550
White Medina		645
Red Shale		660
Total Depth	660 Feet.	

Log No. 46.

Lot.	Concession.	Township.	County.
S. J. Crosby farm		Canboro	Haldimand.

Estimated Production, 105,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Niagara		220
Grey Shale		460
Red Medina		540
White Medina		623
Red Shale		648
Total Deqth	648 Feet.	

Log No. 47.

Lot.	Concession.	Township.	County.
3	III.	Caistor	Lincoln.

Estimated Production, 97,400 cubic feet.

Formation	Thickness of Formation	Total Depth
Surface	68	
Niagara	178	246 ft.
White Lime	60	306
Casing Shale	35	341
Clinton	25	366
Red Medina	38	404
Blue Shale	61	465
White Medina	18	483
Red Shale	30	513
Total Depth	513 Feet	

LOG NO. 48.

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
26	II.	BERTIE	WELLAND

Estimated Production, 40,000 cubic feet.

Formation	Thickness of Formation	Total Depth
To Top of Clinton	702	
Clinton	33	735 ft.
Red Medina	93	828
White Medina	18	846
Red Shale	41	887
Total Depth	887 Feet.	

LOG NO. 49

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
1	I.	BINBROOK	WENTWORTH

Estimated Production, 90,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Clay	74	
Brown Lime	76	150 ft.
Niagara	115	265
Casing Shale	40	305
Clinton	30	335
Red Medina	35	370
Blue Shale	55	425
White Medina	10	435
Red Shale	50	485
Total Depth	485 Feet.	

LOG NO. 50.

LOT.	CONCESSION.	TOWNSHIP.	COUNTY
1-2	IV.	BINBROOK	WENTWORTH

Estimated Production, 40,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Clay	69	
Brown Lime	76	145 ft.
Niagara	115	260
Casing Shale	40	300
Clinton Sand No. 1	30	330
Red Medina Sand No. 2	35	365
Blue Shale	54	419
White Medina Sand No. 3	8	427
Red Shale	50	477
Total Depth	477 Feet.	

LOG NO. 51.

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
120	VII.	BAYHAM	ELGIN

Dry Hole. Plugged.

Formation	Thickness of Formation	Total Depth
Brown Lime		150
Blue Lime		725
Niagara Lime		910
Shale		1165
Red Medina		1237
Total Depth	1237 Feet.	

LOG NO. 52.

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
4	III.	N. DORCHESTER	MIDDLESEX

Dry Hole. Plugged.

Formation	Thickness of Formation	Total Depth
Surface	110	
Grey Limestone	59	169 ft.
Brown Lime	361	530
White Limestone	43	573
Grey Limestone	147	720
Gypsum, Shale & Lime	59	779
Hard & Soft Shale	153	932
Guelph Lime Gas Sand	25	957
Shale	35	992
Hard Blue Shale	20	1012
Total Depth	1012 Feet.	

LOG NO. 53.

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
4	III.	N. DORCHESTER	MIDDLESEX

Dry Hole. Plugged.

Formation	Thickness of Formation	Total Depth
Clay Stones and Gravel	117	
Gray Lime	72	189 ft.
Brown Lime	341	530
White Lime	43	573
Grey Lime	147	720
Gypsum	59	779
Shale	156	935
Guelph Lime	25	960
Shale	35	995
Guelph Lime	25	1020
Brown Lime	40	1060
Niagara	43	1103
Total Depth	1103 Feet.	

LOG NO. 54.

LOT.	CONCESSION.	TOWNSHIP.	COUNTY.
4	III.	N. DORCHESTER	MIDDLESEX.

Estimated Production 250,000 cubic feet.

Formation	Thickness of Formation	Total Depth
Clay & Stones	121	
Grey Lime	58	179 ft.
Brown Lime	358	537
White Lime	39	576
Grey Lime	149	725
Gypsum	57	782
Shale	163	945
Guelph Lime	25	970
Hard Shale	20	990
Total Depth	990 Feet.	

OIL FIELD OPERATIONS, 1920.

by

E. S. Estlin

The present oil-producing area of Ontario may be described as occupying all that portion of the southwestern peninsula south of a line drawn from Welland to Sarnia. Numerous fields of more or less importance, are scattered throughout this area, the chief of these being Petrolia, Oil Springs, Bothwell, township of Dover West, township of Tilbury East. Dutton, township of Sarnia, township of Mosa.

It is encouraging to note that the total production from these fields between the years 1919 and 1920 shows a smaller decline than the previous year. The 1919 production showed a falling off of 23.7 per cent. from 1918, but 1920 shows only a decline of 17.2 per cent.

Table I gives a comparison of the production from the oil areas of Ontario which shows a small falling off in some individual fields and a considerable gain in Moore township. The Onondaga and Thamesfield fields showed an increase; Plympton remained about normal.

The gain in Moore township and the normal output of Plympton may be accounted for in part by the efforts of the Department in maintaining an energetic campaign of plugging and caring for abandoned and drowned-out wells, which if neglected, seriously interfere with the working of adjacent wells and, in some instances, drown them out. In cases where several wells are affected by fresh water invading the sands from an adjacent well, or from the surface, it takes careful attention to reveal the offending well and apply the correct remedy.

The production of the several fields during a period of five years was as follows:—

TABLE I.—CRUDE PETROLEUM PRODUCTION,[1] BY FIELDS, 1916-1920.

FIELD		1916	1917	1918	1919	1920
		Bbls.	Bbls.	Bbls.	Bbls.	Bbls.
Petrolia and Enniskillen	Lambton	142,208	74,267	65,467	70,087	65,082
Oil Springs			46,902	44,671	45,245	39,388
Moore township			6,282	6,367	4,029	7,036
Sarnia township			4,494	3,438	4,259	3,495
Plympton township			579	412	560	531
Bothwell		33,856	29,682	29,116	29,425	26,563
Dover, West.	Tilbury	16,297	10,041	25,228	16,705	12,171
Tilbury, East					1,660	623
Dutton		2,852	2,941	1,875	1,272	837
Onondaga township		1,617	383	1,186	197	341
Belle River		46	....	447	....	....
Mosa township		....	20,999	108,988	45,860	24,063
Thamesville		....	6,420	1,565	801	1,131
Total Production	Bbls	196,876	202,990	288,760	220,100	181,750
Value	$	387,846	475,000	781,097	632,789	724,145
Average Price per Bbl[2]		1.98	2.34	2.70½	2.87½	3.98½

The Bothwell, Oil Springs and Petrolia production was seriously affected by the hurricane which occurred on November 29th, 1919. This storm wrecked the three-pole derricks by the hundred, and damaged operating equipment to such an extent that it was some months before normal operation was resumed. The larger operators suffered more severely because of the greater number of wells worked from central power plants, while smaller scattered groups of wells were more quickly restored to normal conditions.

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[1] Figures supplied to the Ontario Department of Mines by J. C. Waddell, Supervisor of Petroleum Bounties, Petrolia.

[2] Producers of crude petroleum in Canada receive in addition a bounty under the "Petroleum Bounty Act" of 1½ cents per Imperial gallon or 52½ cents per barrel (35 gals.) from the Dominion Government.

TABLE II.—PRODUCTION OF CRUDE PETROLEUM IN ONTARIO FOR 15 YEARS[1].

YEAR	BARRELS (35 GALS.)	GALLONS (IMPERIAL)	YEAR	BARRELS (35 GALS.)	GALLONS (IMPERIAL)
1906	588,962	19,928,322	1914	212,495	7,437,356
1907	779,876	27,621,851	1915	214,442	7,505,478
1908	528,959	18,479,547	1916	196,876	6,890,681
1909	420,660	14,723,105	1917	202,990	7,104,700
1910	314,410	11,004,357	1918	288,760	10,106,615
1911	288,634	10,102,081	1919	220,100	7,703,515
1912	240,935	8,432,730	1920	181,750	6,361,234
1913	226,165	7,915,761			

A typical oil field in Ontario.

Development Work and Prospecting

Some attention has been given to prospecting in Dufferin county, and drilling is now being done.

The formations consist of the Lorraine shales in the north-eastern part of the county, and in the southwestern, of the Guelph limestone, while intermediate is the Niagara escarpment, topped by the Niagara and Clinton limestones, and bordered below by the Medina shales. The geological sections will therefore range from the Guelph downward, according to the location of the well.[2]

Drilling operations are being carried on near Shelburne by the Canadian Oil Fields, Limited, also by James Pickering and the Chamberlain Coal and Oil

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[1] The above figures of production in barrels and the equivalent in Imperial gallons have been abstracted from the annual reports of the Ontario Department of Mines.

[2] Pet. & Nat. Gas Resources of Can., 1915, Dept. of Mines, Ottawa, Vol. II, Page 123.

Development Company. Several other persons and syndicates are making preparations to exploit this region.

The Valley Oil and Gas Company, are drilling in the Dundas valley.

In Raleigh township, the Ajax Gas and Oil Company have drilled five wells. While these borings were originally intended for determining the structure conditions, some very encouraging production was struck about one hundred feet in the Corniferous. The Eureka Oil and Gas Company have also drilled three producing wells in the same district. The Border Cities Oil and Gas Company are beginning a well close to those of the Companies mentioned.

In Dover township there has been considerable development work. Besides the five producing oil wells of the Union Natural Gas Company, the Petrol Oil and Gas Company have two producing wells which are holding their oil and gas production fairly steadily.

The Vacuum Oil and Gas Company are finishing a well in this township and have struck some production: the well is being shot and tubed, and the expectation is that the flow will increase when the well is completed.

The Thames Oil and Gas Company are also drilling in this vicinity.

The Inland Oil and Gas Company drilled four wells near Thamesville, the first two showing considerable production at first.

The Dover Oil Company report preparations under way for active development work in the Dover field, and on their several other properties in the older fields.

It is reasonable to expect something of a revival in the development of the petroleum deposits of Ontario, in the near future. New ground is being tested, and operators in the old producing oil fields are improving their equipment and giving their wells closer attention.

Hydro-electric power is being installed in many cases for pumping purposes and is found to be very satisfactory. The motors impart a steady motion, and require very little attention as compared with gas engine or steam power.

TABLE III.—OIL WELLS, DRILLED AND PLUGGED, IN ONTARIO, 1920.

TOWNSHIP AND LOCALITY	WELLS DRILLED		WELLS PLUGGED
	PRODUCING	DRY	
Enniskillen		1	128
Oil Springs			25
Bothwell	1	1	7
Mosa			10
Thamesville			9
Dawn			10
Ekfrid		5	8
Brooke		2	2
Sarnia	2	1	27
Moore	3	2	16
Plympton		2	31
Adelaide	1	2	
West Williams		1	
Euphemia			2
Wallacetown			10
Total	7	17	285

It will be noted by examining Table III, that 128 wells were plugged in Enniskillen during the year. Notwithstanding this, the falling off in production was not very serious, being 5,000 barrels. This is of course, the largest and oldest field in the Province, and the decline will probably be more than made up on account of the damage these wells were doing to the producers, up to the time they were plugged.

Plympton township comes next with 31 wells plugged, with practically no decline.

Sarnia township had 27 wells plugged, with a decline of only 765 barrels in the year.

In Oil Springs field 25 wells were plugged, and the production was well maintained.

This means that with 285 wells plugged in the year, the decline in production is being checked, and that the effort put forth in hunting for and treating the malignant wells that have been flooding whole areas for years, is well repaid.

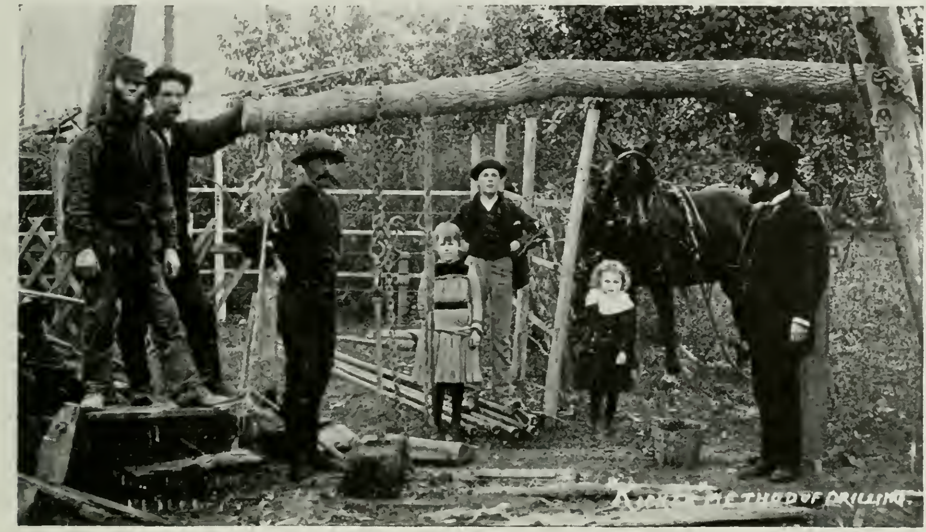
The Table of Prices which follows was obtained through the courtesy of the Imperial Oil Company at Sarnia, and shows how the prices for Ontario crude varied throughout the year.

TABLE IV.—CANADIAN CRUDE OIL PRICES IN 1920, BY FIELDS

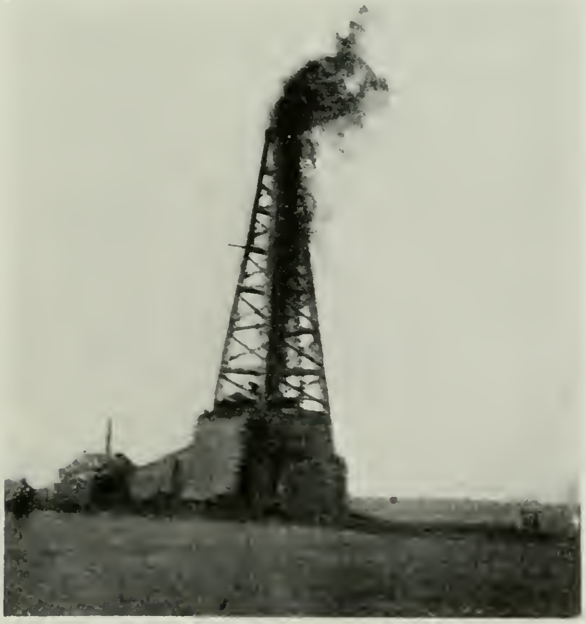
	JAN. 1-JAN. 11	JAN. 12-FEB. 29	MAR. 1-MAR. 9	MAR. 10-OCT. 18	OCT. 19-DEC. 31
PRICE PER BARREL AT	$ c.	$ c.	$ c.	$ c.	$ c.
Petrolia	3.38	3.63	3.88	4.13	4.13
Bothwell	3.28	3.53	3.78	4.03	4.03
North Glencoe	3.28	3.53	3.78	4.03	4.03
Thamesville	....	....	....	....	4.03
PRICE DELIVERED, SARNIA OR PETROLIA.					
Onondaga	3.45	3.70	3.95	4.20	4.20
Dutton	3.45	3.70	3.95	4.20	4.32
Blakely	3.41	3.66	3.91	4.16	4.16
Bothwell	3.45	3.70	3.95	4.20	4.32
Oil Springs	3.45	3.70	3.95	4.20	4.20
Cainsville	3.45	3.70	3.95	4.20	4.20
Belle River	2.84	3.09	3.34	3.59	3.59
Fletcher	3.32	3.57	3.82	4.07	4.07
Glenwood	3.32	3.57	3.82	4.07	4.07
East Tilbury	3.32	3.57	3.82	4.07	4.07
Thamesville	3.45	3.70	3.95	4.20	4.32
Inwood	3.45	3.70	3.95	4.20	4.20
North Glencoe	3.45	3.70	3.95	4.20	4.32

Old and New Methods of Drilling for Oil.

The illustration showing the "kicker" or spring-pole method of drilling is of considerable interest. This photograph was taken 48 or 50 years ago during the drilling an oil well for the late John Kerr. The well was situated in the town of Petrolia. The persons seen in the photograph are said to have all passed away except the children. Reading from left to right they are Jim Love, and John Adams, (the "kickers" standing on the platform) then the driller standing close to the well is Wm. Stokes. The two children are said to be Kenneth and Mary Kerr, and John Kerr, the owner of the well, is standing on the extreme right. The horse was the sole means of pulling the tools and pipe and baling the well. By this means wells were put down about 350 feet and a 3-inch drill was generally used.



The old method of drilling—a "kicker" outfit.



The modern method—a "standard" drilling rig.

This cut of an oil derrick is taken from a well in Dover township which is being "shot." At the moment of snapping the camera, about three hundred quarts of nitro-glycerine were exploding some 3,300 feet below, and the hazy appearance of the picture is probably due to the vibration of the derrick as the dislodged matter was hurled against it.

Refining Operations

Four refineries operated in the Province in 1920, as noted hereunder:

PETROLEUM REFINERIES

COMPANY	LOCATION OF REFINERY	DAYS OPERATED	HEAD OFFICE ADDRESS
British American Oil Co., Ltd.......	Toronto, Cherry St....	365	Toronto, Royal Bank Bldg.
Canadian Oil Companies, Limited...	Petrolia..............	305	Petrolia.
Great Lakes Oil Refining Co. Ltd....	Wallaceburg..........	242	Toronto, 812 Excelsior Life Bldg.
Imperial Oil, Limited.............	Sarnia...............	366	Sarnia.

The following table, summarized from annual reports of the Ontario Department of Mines, shows refinery operations for the past five years:

TABLE V.—STATISTICS OF PETROLEUM REFINERIES, 1916-1920.

SCHEDULE	1916[1]	1917	1918	1919	1920
Crude petroleum production Imp. gals..................	6,890,681	7,104,700	10,106,615	7,703,515	6,361,234
Value do $	387,846	475,000	781,097	632,789	724,145
American Crude, distilled, Imp. gals................	84,143,603	122,436,923	137,065,788	141,157,309	148,540,511
Value do $	4,932,598	9,236,033	12,612,882	12,486,174	20,102,784
Canadian Crude, distilled, Imp. gals................	7,437,382	8,122,062	9,513,222	7,693,385	6,402,118
Value do $	403,316	559,435	781,703	661,927	769,775
Per cent. of total...........	8.12	6.22	6.49	5.17	4.13
Products:					
Illuminating oil....Imp. gals.	25,405,296	40,195,774	36,211,715	34,800,233	33,897,891
Value do $	1,999,261	3,457,817	4,239,816	5,073,647	6,331,706
Lubricating oil......Imp. gals.	10,373,508	12,288,466	12,595,305	12,501,385	13,804,074
Value do $	1,059,526	1,586,270	2,118,002	2,293,640	3,276,569
Benzine, Naphtha, Gasoline, ...Imp. Gals.	24,344,319	34,611,056	39,156,447	44,625,590	47,418,420
Value do $	5,077,314	8,292,828	10,244,328	11,677,077	14,485,935
Gas and Fuel oil, Tar. Imp. gals.	15,224,382	39,815,106	40,949,358	40,581,499	45,025,050
Value do $	686,800	2,671,414	2,943,503	2,265,457	5,486,636
Paraffin Wax and Candles. .lbs.	8,834,945	12,649,553	13,650,128	10,903,202	10,398,127
Value do $	631,560	908,996	1,148,726	1,044,798	973,805
Employees...........Ave. No.	1,161	1,289	1,312	1,580	1,736
Wages paid..................$	867,071	1,259,344	1,486,677	2,045,072	2,695,507

[1] The figures for the year 1916 are for the Canadian Oil Companies, Ltd., and Imperial Oil, Ltd.

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DEPARTMENT OF MINES

HON. H. MILLS, MINISTER OF MINES — THOS. W. GIBSON, DEPUTY MINISTER

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1921

Boston-Skead Gold Area
By A. G. Burrows and P. E. Hopkins
and
Black River Area
By D. G. H. Wright

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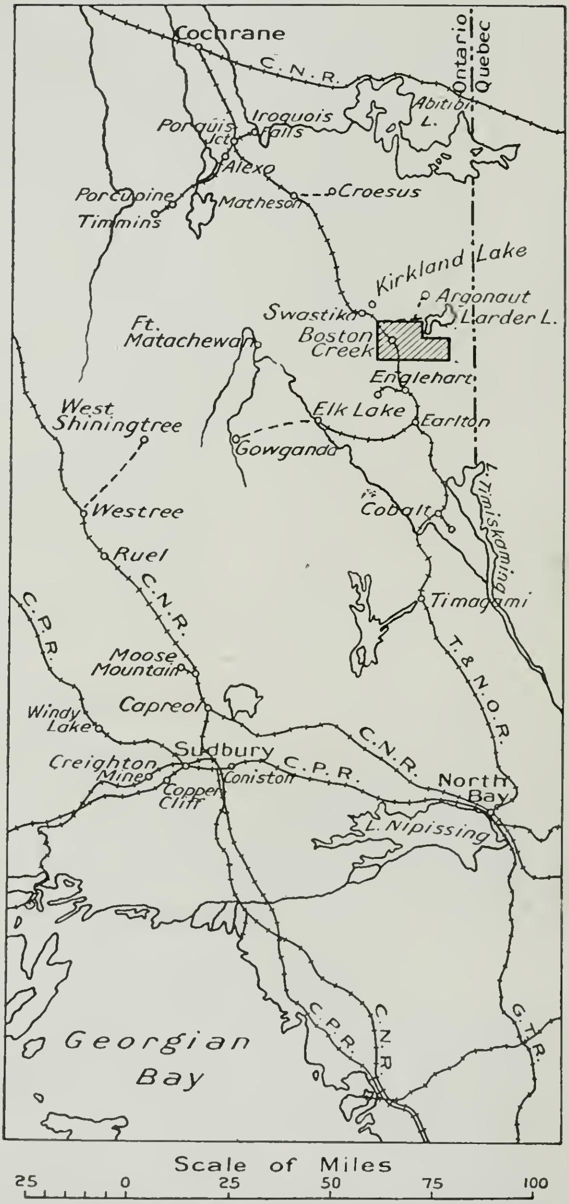

Key map showing the Boston-Skead Area (hatched) as related to other mineral areas in Northern Ontario.

BOSTON—SKEAD GOLD AREA

(Second Report)

By A. G. Burrows and P. E. Hopkins.

A report and map No. 25 d. were issued on the Boston Creek Gold Area in 1916. The area included the township of Pacaud and portions of the townships of Boston, McElroy and Catharine, in the vicinity of Boston Creek. The map accompanying the second report has been enlarged to cover in addition Catharine and Skead townships, where for several years there has been considerable prospecting activity with the discovery of gold on several properties. Further field work was done near Boston Creek in June, 1919, while the township of Skead was examined in May, 1921. The writers were ably assisted by A. W. Carlyle and K. B. Heisey in 1919, and by A. R. Clarke and D. E. Kearney in 1921. The writers wish to express their thanks to the mine officials and prospectors for their many courtesies.

The region is situated in the district of Timiskaming about 45 miles northwesterly from Cobalt and is traversed by the Temiskaming and Northern Ontario Railway. Boston Creek station, mileage 153, is approximately in latitude 45° N and longitude 80° W. By rail Boston Creek station is 382 miles north of Toronto. A wagon road, first constructed to the Miller-Independence mine, has been extended across Catharine into Skead township. The easterly part of the area is also reached by a good wagon road from Englehart.

A section of the Boston Creek-Skead road, west of the Blanche river.

Claims were staked for gold in this area in 1906 and 1907, during the days of the Larder lake gold rush. Again, in 1913, during the activity at Kirkland lake, 12 miles to the northwest, many claims were restaked and some work was done on them. Since May, 1915, following operations on the R. A. P. and Boston Creek gold mines in Boston township, there has been considerable activity from year to year. A small amount of bullion has been produced at the Patricia and Miller-Independence mines, but up to this time no steady gold producers have been developed.

Early Exploration of the Area

The first exploration was by Walter McOuat[1] who, in 1872, made a reconnaissance survey of the Blanche river from Lake Timiskaming to Round lake.

W. G. Miller[2], Provincial Geologist, in 1900 described a portion of the area. In his report the geology along the Blanche river in McElroy and Catharine townships is described. He also mentions prospecting for gold on a 4-foot quartz vein in the hill west of the lower end of a portage which is now shown in lot 9, concession III, Catharine township.

In 1904, after the discovery of Cobalt, W. A. Parks,[3] of the University of Toronto, made a geological survey of this portion of the country. Parks remarks that the high hills along the Blanche, in the township of Catharine, are well worth prospecting for gold.

In 1908 and 1909, M. E. Wilson examined the Larder Lake gold area, which is located to the northeast of Boston Creek. The geological map accompanying his report[4] takes in Skead township which is also shown on the Boston-Skead sheet.

Scene on St. Anthony lake, Skead township.

Topography

The area in general has an elevation varying from 700 to 1,050 feet above sea level. Boston Creek station has an elevation of 920 feet. While the difference in elevation is seldom more than 200 feet, the country is somewhat rugged and broken, particularly in the vicinity of Boston Creek station and along the north branch of the Blanche river in McElroy and Catharine townships.

The country is situated south of the continental divide, and is drained by three branches of the Blanche river and their tributaries which flow southward into Lake Timiskaming.

The magnetic declination is about 8 to 9 degrees west of north.

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[1] Report on an examination of the Country between Lakes Timiskaming and Abitibi, Report of Progress, Geol. Sur. Can., 1872-73, pp. 112-135.

[2] Lake Timiskaming to the Height of Land, 11th Report Ont. Bur. Mines. 1902, pp. 214-230.

[3] The Geology of a District from Lake Timiskaming Northward. Summary Report, Geol. Sur. Can., 1904, pp. 108-225.

[4] Geology and Economic Resources of Larder Lake District, Memoir No. 17E., Geol. Sur. Canada, 1912.

General Geology

The rocks of the area covered by the accompanying geological map are of pre-Cambrian age. The dominant formations are members of the Keewatin, while formations of later age occur in relatively minor quantity, with the exception of a batholith of Algoman granite which covers the greater part of Pacaud township, and areas of conglomerate and greywacké of the Cobalt series in the east and south parts of Skead township.

The intrusive rocks, including granite and porphyry, which are believed to be associated with the gold mineralization, occur in small masses or narrow dikes through the older rocks.

LEGEND

PLEISTOCENE.	
GLACIAL AND RECENT—	Boulder clay, sand and gravel.
PRE-CAMBRIAN.	
KEWEENAWAN—	Quartz diabase, olivine diabase.
	Intrusive Contact.
ANIMIKEAN— (Cobalt Series)	Conglomerate, greywacké, quartzite.
	Unconformity.
ALGOMAN—	Hornblende and biotite granite, syenite, feldspar-porphyry, quartz-porphyry, lamprophyre.
	Intrusive Contact.
HAILEYBURIAN—	Serpentine.
	Intrusive Contact.
TIMISKAMIAN(?)—	Schistose conglomerate, greywacké, slate.
	Unconformity.
KEEWATIN—	Grey schist (volcanic fragmental), ellipsoidal, amygdaloidal and spherulitic lavas, diabase (in part altered to hornblende and chloritic schist), felsite, andesite, dacite, iron formation, rusty weathering carbonate.

Keewatin

The Keewatin rocks, which have such a wide distribution, occur in bands with a general northwest and southeast strike. In the southwesterly part of the area the Keewatin consists of volcanic fragmental material, for the most part fine-grained and irregularly banded. These rocks are about one-half a mile in width in the vicinity of Boston Creek station and extend for about seven miles, following the periphery of a batholith of granite in Boston, Pacaud and Catharine townships. Following across this band to the northeast there is a width of nearly two miles of lava flows, the principal rocks of which are basic lavas, altered basalt, and non-pillow lavas with diabasic texture. With these flows there are some light-colored volcanics, probably rhyolite, together with narrow bands, a few feet in width, of much crumpled iron formation, slate-like rocks, and rusty weathering carbonate. These rocks occur in the vicinity of the Miller-Independence, Allied, Boston-McRae, Authier, Patricia, Roger-Barnett and other properties along a northwest-southeast strike. A third band of Keewatin runs across the southwest part of McElroy township, through Catharine to Skead and Bayly townships. These rocks are usually light-greenish in color, consisting of felsite, or andesite, and dacite, together with agglomerate. The agglomerate occurs in large volume in McElroy and Catharine townships, whereas the andesite is more prominent in the southwest part of Skead township.

The light-colored rocks are followed to the north-east by more basic lavas, iron formation and rusty weathering carbonate, prominently shown near the Blanche river in McElroy township and in the central part of Skead township.

The Keewatin rocks throughout the area are frequently altered to schist, being designed by such terms as sericite, hornblende and chlorite schist. Generally, the altered rocks contain considerable carbonate of lime, magnesia and iron, which, when present in quantity, gives a grey color to freshly broken surfaces, but is rusty brown at the outcrop.

Volcanic Fragmental.—A belt of banded, greyish-green schist, resembling an altered sediment has been differentiated on the map. These rocks, which occur on the periphery of a granite and syenite mass, are about one mile in width and 7 miles in length, passing in a semi-circular shape from Lot 12, Concession II, Catharine, through Boston Creek station to Round lake. The rocks may be best seen in the vicinity of Boston Creek station, where deep railway cuts have been made. The schist approaches a vertical altitude, with a strike parallel to the periphery of the granite. A great portion of the series consists of narrow alternating bands of rusty carbonate (including some magnetite and pyrite bands) and slate. Ash rocks, with bomb-like inclusions, are common. Some thin sections represent greywacké and quartzite, while one is clearly an altered porphyry. The whole series is greatly metamorphosed by the large granite mass, and is cut by narrow porphyry, lamprophyre and other dikes. In the vicinity of Round lake, much altered diabase and green chloritic dikes are intruded into the banded schist. At mileage 153 on the Temiskaming and Northern Ontario railway three bands of pyrite occur in the grey schist. The series was probably laid down conformably with the Keewatin pillow lavas.

Basalt, etc.—The greenstones are fine-grained, and consist of altered basic volcanics which are sometimes schistose, but more often massive. They commonly show the amygdaloidal and ellipsoidal structure, and more rarely the spherulitic, indicating their volcanic origin. The spherulitic structure, which is rare in basic rocks, has not been noted before in this section of Ontario. What may be the spherulitic structure in greenstone was reported on the north shore of Doig lake, in the northwest corner of Lebel township[1]. A similar structure was also seen under the microscope in an acid rock, a rhyolite, from lot 6, concession III, Beatty township[2]. In this area, spherulitic greenstones are beautifully developed on a bare hill on claim L 1878, Boston township. The varioles, which are rounded and white-weathering, vary in size from minute pea-like form to those about two inches in diameter, and constitute a large part of the rock. Under the microscope the varioles consist of coarse radiating flakes of chlorite, feldspar, epidote and probably quartz in a fine groundmass of the same material, and actinolite.

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[1] Kirkland Lake and Swastika Gold Areas, Report Ont. Bur. Mines, Vol. 23, Pt 2, 1914, p. 4.

[2] Beatty-Munro Gold Area, Report Ont. Bur. Mines, Vol. 24, Part 1, 1915, p. 176.

Throughout the whole rock are pyrrhotite grains and numerous black ferruginous specks. The rock is probably an altered basalt. A similar spherulitic basalt occurs on the Roger-Barnett property in Catharine township.

The pillow lava flows constitute the main portion of the greenstone. They are interbedded in a northwest-southeast direction with much non-pillow greenstones, which have a diabasic texture at times, and some tuff, agglomerate and slate which point to a subaqueous origin. The nearly complete alteration of the greenstones, with the retention of their original ellipsoidal structure, is, according to Leith and Van Hise, due to the metasomatic rather than a dynamic change. Under the microscope the original minerals in the greenstones are hornblende, quartz, magnetite and plagioclase, the altered plagioclase laths suggesting a basaltic or diabasic texture. The secondary minerals are calcite, hornblende, chlorite, sericite and quartz. The altered greenstone in places may be spoken of as hornblende or chlorite schist.

Andesite, Dacite and Agglomerate.—A belt of light greenish-colored rock lying between two bands of basic lavas runs diagonally across the townships of McElroy, Catharine and Skead. There are several types of rocks in this group, the most prominent of which is andesite. It occurs in large volume in the vicinity of St. Anthony lake, extending southerly into Bayly township. The rock is usually fine-grained, resembling felsite, but phenocrysts of plagioclase are frequently recognized. Under the microscope the feldspar phenocrysts are set in a groundmass of feldspar, chlorite, epidote and calcite. Occasional irregular masses of chlorite suggest an alteration from a ferro-magnesian mineral. The following analyses (1) and (2) show the composition of the rock.

TABLE I.—ROCK ANALYSES.

	(1)	(2)	(3)
Silica	60.46	63.78	68.56
Alumina	16.85	15.86	15.16
Ferrous oxide	4.19	2.66	0.99
Ferric oxide	1.70	0.96	3.23
Lime	4.70	5.01	2.26
Magnesia	1.36	2.58	1.51
Potash	0.52	0.25	1.04
Soda	4.82	4.96	6.10
Carbon dioxide	3.98	2.67	0.22
Water	0.90	1.42	1.22
Total	99.48	100.15	100.29

(1) N.½ lot 7, con II, Skead township. (2) South boundary of Skead township in lot 4. (3) East side St. Anthony lake. Analysis—W. K. McNeill and T. E. Rothwell, Provincial Assay Office.

Intruding the andesite in the form of irregular dikes and stocks, there is a coarse-grained porphyritic rock of light greenish color, which is probably a dacite or quartz-diorite-porphyry. The prominent minerals are quartz and plagioclase, and occasional ferromagnesian mineral, altered to chlorite, in a groundmass of feldspar, chlorite and epidote. The rock has likely been derived from the same magma as the andesite. It occurs prominently to the east of St. Anthony lake, A specimen of the rock has the composition shown in column (3) above.

With the andesite type of rock, particularly in McElroy and Catharine townships, there is a fragmental rock of volcanic origin. It contains numerous fragments of light-colored volcanic rocks together with some fine-grained, stratified, ash-like material. It is well exposed along the boundry between McElroy and Catharine, in lots 10, 11 and 12.

Iron Formation.—Iron formation, consisting of interbanded silica, black slate and magnetite, occurs with greenstone on a number of claims among the Dane-Larder Lake road in Boston township. This range has been described in detail by W. G. Miller[1] and other writers[2].

There are a number of narrow bands of the formation in McElroy township to the west of the Blanche river. Some of these carry considerable iron pyrites, and on claim 4410 a small quantity of iron pyrites has been separated from the silicious iron formation during the sinking of a shaft.

Similar narrow bands occur on the Fidelity claims north of St. Anthony lake. The formation has been fractured and contains vainlets of quartz carrying pyrites. Gold has been obtained in material from prospect pits on several outcrops of iron formation.

Carbonate Rock.—Bands of rusty-weathering carbonate of lime, magnesia and iron occur in parts of the area. These have the prevailing strike of the district namely, northwest and southeast. Generally they are cut by irregular veinlets of quartz and sometimes by masses of porphyry. Several of the outcrops have been partially prospected for gold. These include the Cook property in the northwest part of Skead and the adjoining part of Hearst township, and the Lincoln-Nipissing claim, C.E. 3, Skead township.

Timiskamian

A few small, isolated patches of schistose conglomerate, slate and greywacké, standing in a vertical attitude, occur along the Larder Lake road in Boston and McElroy townships. The rocks are similar to the sediments classed as Timiskamian on the map of the Kirkland Lake and Swastika gold areas. The pebbles of the conglomerate, which are elliptical in outline, consist largely of greenstone and felsite and some iron formation. A grey magnesian limestone occurs both as pebbles and matrix in the conglomerate in McElroy township about a mile east of the three-mile post on the west boundary.

There is an area of schistose sedimentary rocks in the north and northeast parts of Skead township. The series is represented by slate, quartzite and conglomerate, which, in places, are greatly altered and difficult to determine.

The conglomerate in the northeast corner of lot 6, concession VI, Skead township, contains many pebbles 2 inches in diameter, some of which are quartz-porphyry, granite and greenstone. In the southeast corner of the same lot the bedding of the conglomerate and greywacké is north and south, while the schistosity is northeast-southwest. The usual strike and dip of the beds in the sediments is much the same as the Keewatin lavas, namely, northwest-southeast and nearly vertical dips.

Pre-Algoman (Haileyburian?)

Serpentine.—There are isolated exposures of serpentine in various parts of the area.

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[1] Boston Township Iron Ranges, Vol. XIV, Ont. Bur. Mines.

[2] Kirkland Lake and Swastika Gold Areas, Vol. XXIII, Part II, Ont. Bur. Mines.

The trail on claim L. 4902, Boston township, passes over an exposure of serpentine. A thin section of the rock was examined microscopically and found to consist of about 60 per cent. serpentine and 40 per cent. calcite. Numerous magnetite grains and a little pyrite are scattered through the rock.

Serpentine occurs in small areas on and north of claims W.R. 97, to the west of the Blanche river, McElroy township, and in the northern part of Catharine township.

The largest exposures of serpentine are scattered across the northerly part of Skead township. The rock is readily recognized in the field by its light weathered surface and greasy feel in freshly broken fragments. No chromite, or asbestos, was recognized in specimens from the various serpentine outcrops.

Algoman

These rocks include batholith and stocks of granite and syenite, and dikes of feldspar-porphyry and lamprophyre. They are massive, fresh-looking, and are probably Algoman in age, since similar granite in Boston and Lebel townships to the north was found cutting the Timiskamian series.

Granite and Syenite.—A batholith of red, biotite granite occupies nearly all of Pacaud township, and extends to the south and west for miles beyond the township boundaries. The rock is massive, except near the contact with the Keewatin, where it occasionally takes on a gneissoid structure. Near the contact with the greenstone, just south of mileage 153, the granite is intruded by numerous parallel felsitic dikes which give the rock a banded structure. It is cut by quartz veins, and by pegmatite and other dikes representing various differentiation facies of the magma. The rock in the south part of lot 9, concession VI, Pacaud, is a light grey, medium-grained biotite granite. Under the microscope microcline is seen showing the gridiron structure, albite partly altered to sericite, biotite altered partly to hornblende and chlorite, quartz and calcite.

A reddish syenite outcrops in the west part of Boston township, being part of the large syenite boss-like mass occupying most of Otto township.

A small stock of reddish biotite and hornblende granite intrudes the greenstones in McElroy township. Gold and a telluride have been found in this granite in a pegmatitic quartz vein which is probably a part of the granite magma.

The gold-bearing quartz veins at the Wisconsin-Skead property in Skead township occur in a dike of red granite with which the gold is probably genetically connected.

Other small irregular, granite dikes cut the greenstones and felsitic rocks. Gold was seen in quartz veins in these small granite dikes on claim L 5165 and L 5133, Boston township.

Feldspar-Porphyry.—Numerous intrusions of massive red and grey feldspar-porphyry occur over the whole area. They appear as narrow dikes up to thirty feet or more in width, and probably represent apophyses from the granite masses. The phenocrysts usually consist of albite, often showing a zonal structure, an occasional rounded quartz grain, and blades of biotite in a microcrystalline groundmass of quartz, feldspar, chlorite and calcite. Fine grains of magnetite and pyrites, and crystals of apatite are often present. A feldspar-porphyry on claim L 2000, Boston township, and in other parts of that vicinity, contains white feldspar phenocrysts up to one inch across, which show beautiful zonal structure in the hand specimen. Some porphyry dikes in the southwest part of Boston township contain many prominent quartz phenocrysts, and thus resemble the quartz-porphyry at Porcupine. In other parts the rock may be called a felsite. The acid dikes are usually cut by minute veinlets of quartz, some of which carry gold. Small, irregular fragments of red feldspar-porphyry are also, at times, present in auriferous quartz veins.

Lamprophyre.—A few narrow lamprophyre dikes cut the greenstones and grey schist, but these are too small to map. They may be seen on the south part of lot 3, concession VI, Pacaud township, and at about mileage 154.3 along the railway. In the Kirkland area the lamprophyre cuts the Timiskaming sediments, but is older than the feldspar-porphyry. A lamprophyre dike that intrudes the Algoman granite can be observed in a rock-cut about half a mile north of Mindoka station.

Some red lamprophyre occurs in the northwest part of Skead township, and the adjacent part of Hearst township. It is associated with porphyry dikes very similar to the occurrence at Kirkland lake. It is also found on the Crawford claims in lot 9, concession V, of the same township.

Animikean

The youngest sedimentary rocks consist of greywacké, quartzite and conglomerate, which occur in prominent ridges in the east and southeast parts of Skead township. They represent erosion remnants of the sedimentary series which can be traced at intervals southerly to Cobalt. The rocks in the vicinity of Hough Lake are 200 or 300 feet in thickness. The sediments are nearly flat-lying, with dip generally up to 15°. On lot 12, concession V, Skead township, a portion of the rocks dip 60° easterly. No deposits of economic importance have been discovered in the late sedimentary rocks in this area. They were deposited subsequently to the deposition of the gold-bearing veins. A portion of the Flannigan gold-bearing vein, on lot 7, concession III, Skead township, is covered by a bed of conglomerate 10 feet in thickness.

Keweenawan

Quartz diabase dikes are rare in this area; however, they were noted cutting the greenstones and Timiskamian(?) sediments. These dikes are classed as Keweenawan, since they are fresh-looking and resemble the diabase at Cobalt. A thin section of a sample taken immediately south of M.R. 15, Boston township, shows labradorite laths, partly altered to saussurite and sericite, augite partly altered to hornblende and chlorite with a little quartz, biotite, magnetite and intergrowths of quartz and feldspar.

There are several outcrops of diabase in the north-east part of Skead township. These represent remnants of the Keweenawan diabase sill. A calcite vein carrying galena, which occurs in this rock, is referred to elsewhere in the report.

Glacial and Recent

The region has been heavily glaciated, the ice having moved in a general S. 20° E. direction, astronomic.

The area lies at the northern edge of a tract of farming land, which extends from Haileybury to Round Lake, and is covered in places with stratified clays, sand and gravels. At Boston Creek Station one can see the vertical section of a morainic deposit which has been cut into by Boston creek. The central part of McElroy township. to the east of the Blanche river, is one vast area of sand and gravel, representing, probably large terminal moraines and outwash plains. The glacial drift extends southerly into Catharine township where it occupies the greater part of the easterly portion of the township. In lot 3, concession III, there are several remnants of old kettle lakes. In this same vicinity the sands are overlain by a thin clay deposit, suggesting damming during glacial times. The sand and gravel also extends easterly into the northwest portion of Skead township, and southerly into Marter township. The gravel ridges are the source of several fine springs, one of which is the headwaters of Spring Creek, in Catharine.

Origin of Gold Deposits

As pointed out by W. G. Miller and C. W. Knight in a paper entitled "Metallogenetic Epochs in the Pre-Cambrian of Ontario,[1]" most of the gold deposits of Ontario belong to the Algoman epoch. The gold deposits of Boston creek supply another example of gold being derived from acid intrusives of Algoman age. The granite, syenite and feldspar-porphyry exposed in this area by erosion are probably different facies of a plutonic rock which underlies the whole area. The gold generally occurs near these acid rocks. The presence of a number of gold-bearing veins along the contact of the intrusive porphyry and older rocks at Boston creek, as in many other parts of central Canada, and the frequent occurrence of auriferous quartz veinlets in the porphyry and granite, suggest the relationship between the intrusives and the veins. The relationship is more clearly shown in this area by the occurrence of gold in a pegmatitic vein in the granite on the Charest claim, McElroy township.

The deposits are in part due to the replacement of the country rock by mineral solution.

Only a few minerals which characterize deposits that are formed at high temperatures are found in the veins at Boston creek. Actinolite was noted in a thin section of material from the Kenzie vein, and specularite has been frequently observed in other veins. Tourmaline formed at high temperature has been noted in quartz veinlets at the Catharine gold property. It is probable that the deposits were formed at great depth, but not at extremely high temperature.

Economic

Gold.—Gold, the chief mineral sought for in the area at the present time, occurs, usually native, but occasionally combined with tellurium, in quartz veins and veinlets in the Keewatin greenstone and later intrusions of granite and porphyry. The veins, which have various strikes and dips, are well mineralized with varying quantities of pyrite and molybdenite, and sometimes with chalcopyrite, galena, specular hematite, cosalite, native bismuth, gold and tellurides. The gangue consists largely of quartz of several generations, with considerable calcite and chlorite. The gold is found along the dark streaks of chlorite and calcite.

There are many types of gold deposits, viz:

(a) Fissure quartz veins in the greenstone, granite and porphyry, with well-defined walls. Examples: No. 1 vein at Miller Independence, Boston-McCrae, Authier, Patricia and Wisconsin-Skead.

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[1] Rep. Ont. Bur. Mines, Vol. XXIV, Part 1, 1915, pp. 243-248.

(b) Replacement veins. The country rock, including altered greenstone and porphyry, has been brecciated and partly replaced by vein-forming solutions of quartz of several generations, and by calcite and other carbonates. Examples: the calaverite vein on the Miller-Independence and the Kenzie vein on the R.A.P. property.

(c) A stockwork in granite and porphyry. Examples: Charest (L. 5305), Authier (L. 4737), and Papassimakes (L. 5133).

The chief deposits will be described later in the report when dealing with the gold claims.

Iron Pyrites.—In the first railway cut north of Boston creek station there are two narrow bands of pyrite, 10 to 20 inches wide, with some disseminated pyrite in the adjoining schist. The pyrite on assay showed the absence of gold; the exposed deposit is of no economic value. Two shallow pits have been put down on the eastward extension of the deposit and at present a little pyrite can be seen on the dumps.

On the Marsh claim, 4410, McElroy township, a shaft has been sunk 80 feet on an iron-formation band some 50 feet in width. Fairly solid pyrite extends over a width of six feet and eight or ten tons of massive pyrite have been separated on the dump.

A twenty-five foot pit has been sunk on a quartz deposit carrying some grains and nodules of pyrite on the Sharp claim, H.S. 914, Rattray township.

Magnetite.—The isolated exposures of iron formation along the Larder Lake road, in Boston township, represent the southern portion of the Boston township iron range. The formation consists of interbanded silica and magnetite, with some black slate. Numerous shallow test pits were sunk in 1902, but the iron proved to be too low in grade to be workable at that time. The iron formation is, in places, intruded by quartz veins, some of which carry gold.

Argentiferous Galena.—There are two occurrences of argentiferous galena in Skead township, one on the *Mageau-Authier* claim, W.D. 1001, in lot 12, concession V, the other on the De Villiers claim on the west central part of lot 12, concession VI. On the former location a 50-foot shaft has been sunk vertically on a quartz-calcite vein in a Keweenawan diabase sill remnant. The vein strikes 15° north of east, averages 6 inches in width, the calcite in places containing galena, zinc blende, cobalt bloom and pyrite.

On the *De Villiers* location is a calcite vein from a few inches to one foot in width, averaging about 6 inches, striking 15° north of east and dipping vertically. The vein, which has been uncovered for a distance of 450 feet, lies in Keewatin diabase and basalt, Timiskamian conglomerate and Algoman porphyry, and apparently passes under a Keweenawan gabbro remnant on the west. The vein contains zinc blende, cobalt bloom, pyrite, and, in places, large pieces of galena which, on analysis, showed 4 ounces of silver per ton and no gold.

Calcite veins carrying galena are reported to have been found on claims L. 66 and L. 67, on lots 11 and 12, concession IV, Skead township.

M. E. Wilson, in his report on the Larder Lake Area, refers to a silver-lead occurence on claim B.G. 229, on the Hearst-McElroy boundary, 4 miles north of Skead township, owned by the *North Canadian Gold Mines, Limited.* "Several irregular veins of galena, blende, and chalcopyrite, up to 10 inches in width, occur in Keewatin greenstone. They all pinch out quickly when followed along the strike."[1]

Building Stone.—The red and grey granite and syenite along portions of the railway in Pacaud township is serviceable for building purposes. The station at Matheson, which was burned in 1916, was constructed of stone taken along the railway immediately to the north and south of Mindoka station.

Timber and Agriculture.—In general the trees are small, and consist of spruce, jack pine, poplar, birch and cedar. A few white pine, three and one-half feet in diameter, to the southeast of Smith lake, have escaped an old fire which swept most of the area. Large charred stubs of pine in various parts of the area are relics of the same fire. Other parts have been recently burned.

Many farms have been located on the scattered clay areas of Pacaud township, while the greater part of the remaining area is unsuitable for agriculture by reason of rock, sand or swamp.

Power.—The Northern Ontario Light and Power Company's transmission line, from Cobalt to Kirkland Lake, passes through the area. The Miller Independence mine is operated by power furnished from this line. The transmission line from Charlton to Kirkland Lake runs along the west boundary of Pacaud and through the westerly part of Boston township. The Wisconsin-Skead Company expects to get power from Raven falls in McFadden township.

The branches of the Blanche river, which flow through the area, have several waterfalls which could be utilized for power. One of these is on the northwest branch in lot 12, concession IV, Pacaud. On August 12th, 1914, the discharge of the river at this point was 350 cubic feet per second. The 61-foot falls in expected to develop 405 horsepower. Immediately to the north, in concession V, is a 36-foot falls which could be utilized to develop additional 240 horsepower.

A larger possible waterpower is situated at High Falls on the north branch in lot 11, concession IV, Marter township, where a total operating head of 138 feet is available. The discharge of the river on May 6th, 1915, was 352 cubic feet per second. Messrs. M. Hotchkin and G. Grover, who surveyed the waterpower at that time determined a minimum of 2,000 horsepower available.

Description of the Gold Prospects by Townships

Boston Township

R.A.P.—The first discovery of gold in Boston Creek was made in 1914 in the "Kenzie" vein, which extends from claim No. L. 3665 to claim No. L. 5163 in the south central part of Boston township. During that year some work was done on the vein by La Rose Mines, Limited. During 1916, the R.A.P. Syndicate, controlled by E. M. Richardson, W. B. Albright and J. K. Papassimakes, continued development on the Kenzie vein on L. 5163. The inclined shaft was sunk to the 200-foot level and drifting done as follows: On the 100-foot level, east drift, 250 feet: west drift, 175 feet; 200-foot level, east drift, 90 feet; west drift, 190 feet. Development has shown the ore to occur in small shoots in the vein. The vein strikes 30° north of east, and dips 65° S. in massive pillow lava. The vein varies from several inches up to 5 feet in width with good breaking walls on either side. The vein material consists of quartz of several generations, silicified rock,

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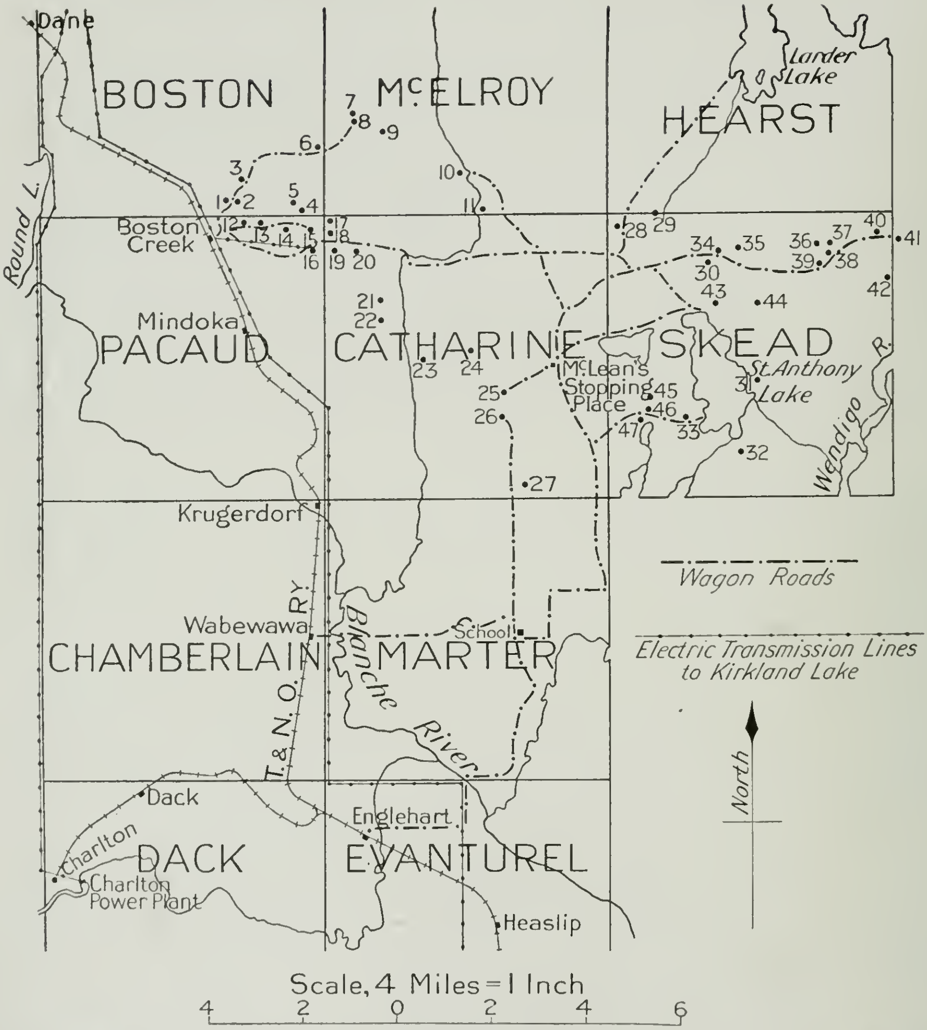
[1] Memoir No. 17 E., Geol. Sur. Canada.



Outline Map of Boston-Skead Area showing the relative locations of the mineral prospects mentioned in this report.

Boston

1 Boston Creek
2 R. A. P.
3 Currie
4 Authier
5 Ivanhoe-Boston
6 Gold Leaf

McElroy

7 Hughes-McElroy
8 Peerless or Mondoux
9 Charest
10 Marsh
11 Irish

Pacaud

12 O'Donald
13 Patricia or Barry-Hollinger
14 Boston McCrea
15 Allied Gold
16 Miller Independence

Catharine

17 Campbell
18 Cotter
19 Connell-McDonough
20 Kennedy-Boston
21 Burnand-Gzowski
22 Catharine Gold
23 Ostrum
24 Daley
25 Walsh-Taylor
26 Roger-Barnett
27 Hounslow

Skead

28 Zenith Gold
29 Cook
30–33 Flanagan
34 Lincoln-Nipissing
35 Manley-O'Reilly
36 Martin
37 Sampson
38 Wisconsin-Skead
39 Crawford-Skead
40–41 DeVilliers
42 Mageau-Authier
43 Fidelity
44 Barry Webster
45 Nigger
46 Skead Gold
47 Telluride Syndicate

reddish calcite, and brecciated and partly replaced masses of reddish feldspar-porphyry. The occurrence of feldspar-porphyry in various parts of the workings suggests that originally the greenstone was intruded by a narrow feldspar-porphyry dike, that at a later period was greatly brecciated and impregnated with vein-forming solutions which carried the gold and other minerals. The gold occurs with a very fine-grained greenish quartz, which has the character of a replacement deposit, while the green colour is due to minute inclusions of chlorite. Iron pyrites is finely disseminated in the vein, and copper pyrites, molybdenite and galena occur in minor quantity.

Thin sections of the ore show the gold to be closely associated with the sulphides in chlorite and calcite seams near the footwall part of the vein, where there is a narrow band of fine-grained greenish quartz. Certain sections of the vein run as high as $25 or $30 in gold to the ton, across five feet.

On the east side of claim L. 2631, which lies immediately northeast of that on which the main shaft is sunk, there is an irregular band of mineralized schist with quartz, about one foot wide, which contains visible gold. The showing occurs where the greenstone is intruded by a dike of feldspar-porphyry, and near the contact.

The plant includes one 60-h.p. Jenckes locomotive-type boiler, and one 5 by 7 Jenckes hoist. Work was discontinued by the syndicate on September 17th, 1916, and the shaft and hoisting equipment rented to the Boston Creek Mining Company. In July, 1917, preparations were under way to take over the shaft and resume work.

Boston Creek.—The Boston Creek Mining Company, Limited, did considerable development work on claim L. 3665 in Boston township during the year 1916. Work was carried on through the R.A.P. shaft, which was rented with hoisting equipment from the R.A.P. Syndicate.

The drifts on the 100 and 200-foot levels of the R.A.P. were extended into the Boston Creek ground and a raise carried to the surface from the 200-foot level. A winze has been sunk 200 feet from the 200-foot level, and stations cut at the 300 and 400-foot levels. Development is as follows: 100-foot level, 325 feet of drifting and cross-cutting; 200-foot level, 300 feet of drifting and cross-cutting; 300-foot level, 50 feet of drifting and cross-cutting; 400-foot level, 300 feet of drifting and cross-cutting.

The vein is a continuation of the "Kenzie" vein from the R.A.P., and similar in appearance. Spectacular gold showings were obtained in the upper 30 feet of the shaft and a few very small shoots were obtained in the deeper levels.

In February and March, 1917, new buildings were erected, including office, sleeping camps, dining-room and store-house. Operations were suspended in July, 1917, to permit of exploration by diamond-drilling. Air is supplied by two Chicago Pneumatic Tool Company fuel-oil compressors.

Ivanhoe-Boston.—On claim No. L. 5079 is a quartz vein of a few inches to 4 or 5 feet in width which strikes northeast-southwest and dips approximately 65° to the southeast with numerous quartz veinlets running nearly at right angles on either side. Some cosalite carrying high values in gold and silver occurs in one portion of the vein. The wall rocks are massive Keewatin diabase and pillow lava which are extremely altered for a few inches next the veins.

Currie (L. 5037).—In the northwest part of the claim are rusty schist bands heavily mineralized with iron pyrites and cut by quartz stringers. No visible gold could be seen in place, but gold colours can be panned from the sulphides. A grab sample showing cubes of pyrite gave $2.40 in gold to the ton, while samples across two feet and three feet seven inches gave $1.60 and 60 cents respectively in gold to the ton.

Authier.— Visible gold has been found on a number of veins on the Authier claims, Nos. L. 4734 and L. 5025, which are situated in the southeast part of Boston township. The veins are from a few inches to three feet in width and occur in greenstone, iron-formation, granite and porphyry. The deposits strike a little north of east and dip from 20° to 45° to the north, although some veins dip to the south. There are often cross veins forming a stockwork. The veins contain much disseminated iron pyrites and small quantities of chalcopyrite, specular hematite, molybdenite, bismuthinite, magnetite and tetradymite, but on the whole sampling has shown the gold content to be low.

Gold Leaf (L. 5757).—A shaft has been sunk on a quartz vein together with numerous stringers of quartz which intersect a reddish, medium-grained hornblende granite. The main quartz vein strikes N. 60° E., and dips 60° northwesterly. This vein is from two to four feet wide and is accompanied by quartz stringers over a width of ten feet. Fifty feet northeast of the shaft the deposit has been faulted to the west with a horizontal throw of thirty feet. The quartz has a somewhat banded character and carries iron pyrites, copper pyrites, pyrrhotite and molybdenite in film-like structures. The property was not in operation at the time of visit.

About a mile west of the Gold Leaf, on claim No. L. 5165, is a similar granite cut by narrow white quartz veins, some of which carry molybdenite and a few specks of native gold.

Pacaud Township

O'Donald.—The O'Donald claim, the N.E.¼ of the N.½ of lot 4, in the sixth concession of Pacaud township, has four nearly parallel E.-W. veins, which dip from 60° to 70° to the south. The south vein, which is considered the most promising, consist of schist, quartz and pyrite, across a width of eight or ten feet. A nineteen-foot shaft was sunk on this vein and later the vein was cut underneath the shaft at a vertical depth of 200 feet by a diamond drill. Neither the Crown Reserve nor the Allied Gold Mines exercised its option. The rocks are Keewatin, diabase and pillow lava cut by aplite, feldspar-porphyry and hornblende -mica syenite.

Patricia.—The Patricia (Barry-Hollinger) consists of two claims in the north half of lot 3, in the sixth concession of Pacaud township. A mining and milling plant was placed on the property and the mine was operated for a short time in 1917 and 1918 by the late C. A. O'Connell. A forest fire in July, 1919, burned the mine buildings and mill, the mine not being in operation at the time. A description of mining and milling operations is given on page 101, Part 1, Vol. 27, Report Bureau of Mines. Twelve veins were found on the property, but underground operations were chiefly confined to vein No. 7, with a small amount of work on a parallel vein to the north. An inclined shaft was sunk 215 feet on No. 7 vein, that dips 74° S, with orepockets at the 100 and 200-foot levels and drifts along the vein on these levels. Two stopes, 25 feet and 130 feet in length, were opened up on the 100-foot level in the west drift, and one stope 80 feet long on the 200-foot level. The stopes were carried up about thirty feet before milling operations were suspended.

The ore is banded quartz of rather fine grain and carries a small percentage of iron pyrites, and some copper pyrites and zinc blende; it frequently shows native gold in hand specimens. The quartz varies in width from about twelve to thirty inches. In the west drifts on the two levels, bands or lenses of calcite were encountered with a narrowing of the quartz. The values are contained in the quartz vein with little mineralization of the enclosing basic rock. The ore raised from the mine was of good grade, approximately $18 per ton.

Boston-McRae.—The Boston-McRae Gold Mines comprises four claims in the north half of lot 2, in the sixth concession of Pacaud township. The rocks are pillow lava and associated volcanic flows with narrow bands of iron formation, the general strike of the formations being N.W. and S.E. The volcanic rocks are partly altered to carbonate. A number of mineralized zones have been found, generally containing irregular veinlets and masses of quartz. A well defined quartz vein, with N. and S. strike and dip 45° E., occurs in the northeast part of the property. An inclined shaft was sunk in 1916 by former operators. The vein averaged about twelve inches in width and visible gold was observed in the hanging-wall at a number of points. This vein is cut by a diabase dike to the south of the shaft. Further work was done near the north line to the west and a shaft started on a series of lenticular quartz veins dipping gently to the east. The shaft was down fifteen feet showing a series of quartz veinlets on the east wall for eight feet from the surface. Native gold and tellurides with iron pyrites have been recognized in the ore. Some faulting was observed in the shaft. The surface where the quartz stringers occur is highly oxidized, this condition being traced to the Authier claim on the north. The rock below the surface shows the characteristic grey colour of basalt altered by carbonate with quartz and sulphide.

On the south central part of the property a shaft has been sunk on a wide schist zone carrying quartz stringers, iron pyrites and copper pyrites and some value in gold. To the east of the shaft there is a serpentine dike and a coarse hornblendite.

Allied Property.—The Allied Mining Co. operated the Renaud-Cullen group, consisting of the north half of lot 1 in the sixth concession of Pacaud township, during parts of the years 1918 and 1919. Much trenching was done on the south central part of the property, where the basalt carries irregular stringers of quartz in a general N.W.-S.E. direction. One trench shows mineralization over a width of sixty feet across narrow bands of quartz in the basalt, the rock being altered along the quartz veinlets to a grey color and containing grains of iron pyrites. A little copper pyrites and calcite occur in the veins. Some low gold assays were obtained in the fractured zone, but no commercial ore was found. Work was also done on the southeast part of the property where the basalt and other Keewatin rocks are intruded by a small irregular body and narrow dikelets of granite. A number of narrow quartz veins, from an inch to a few inches in width, were discovered in the granite or basalt near the contact, and some visible gold with a black telluride found in some veins. Needle-like crystals of bismuthinite were observed in one quartz veinlet. Gold was also found in irregular veinlets of quartz in a red porphyry dike eight feet in width. A shaft was sunk 100 feet on a fracture along an E.-W. basic dike, cutting the Keewatin.

Diamond drilling was done in the vicinity of the south line near the Miller Independence. Three shafts were sunk to moderate depths at an earlier time by former operators.

Miller Independence.—This property, which is one of two in the area which has produced some gold, is situated on the south half of lot 1, in the sixth concession of Pacaud township. Gold was first discovered on the lot in No. 1 vein by Joseph McDonough in July, 1915. Three years later W. Adams, then mine captain, discovered the "Independence Vein," which contains a small shoot of ore carrying a precious telluride, calaverite. All the recent work has been done in connection with this vein.

The geology is comprised dominantly of alternating flows of Keewatin pillow lava (meta-basalt), altered diabase or dacite, with which are associated subordinate amounts of rhyolitic schists, agglomerate, iron-formation and tuffs, all of which have a N.W.-S.E. trend. These rocks are cut by small granite stocks and feldspar-porphyry dikes. In the vicinity of the veins the rocks contain abundant calcium magnesium and iron carbonates.

The original No. 1 vein has been traced on the property for about 600 feet in an east and west direction and for several hundred feet easterly into Catharine township. It is narrow, averaging about a foot in width, and has a low dip to the north, usually about 20° or less, at one place being almost horizontal. The vein material is milky white quartz, and the mineralization is more or less concentrated toward the footwall side of the vein. Tellurides, copper pyrites, pyrite, specular iron ore and galena are observed in the quartz. Native gold occurs frequently with the telluride in a net-like arrangement in the quartz along the footwall. A bismuth telluride, brilliant grey in color, and containing some selenium, occurs abundantly with the gold. A darker-coloured telluride (petzite?) is also present in smaller amounts. The vein has been prospected by means of a number of trenches, pits and shafts from which some high-grade ore was bagged and a small production recorded. Along parts of both walls of the vein there is a narrow dike of grey feldspar-porphyry. The porphyry contains much calcite and other carbonates, as well as disseminated iron pyrites and is cut by veinlets of quartz.

The Independence vein, containing the small shoot of exceptionally high-grade ore, strikes No. 22° E., and dips 55° southeasterly. The rich ore was found between the depths 30 feet and 160 feet in the inclined shaft, but could not be traced for any great distance on the 100-foot level. The hanging wall of the shaft is a strong fault plane. Below this is a second fault plane nearly parallel to the upper one, the planes varying from a foot to three feet apart. Below the lower fault plane is a series of irregular quartz veinlets from a fraction of an inch to one inch in width and roughly parallel to the fault plane. A few veins are terminated sharply at the fault plane, indicating that some of the faulting is later than the mineralization. About ten feet above the 100-foot level the veinlets occur over a width of four feet. These veinlets can be followed down to 160 feet in the shaft below which the rock is less altered. Where the veinlets occur, the dark basalt has been altered for a few inches to a light grey rock carrying abundant iron pyrites. The quartz carries in places iron pyrites and copper pyrites together with gold telluride, calaverite. The telluride occurs chiefly in minute veinlets and small masses in and with the copper pyrites and is sometimes accompanied by native gold. Faulted sections of flat-lying quartz veins were observed between the main fault planes about fifty feet below the 100-foot level.

Shaft No. A has been sunk vertically to a depth of 500 feet and extensive exploration carried on at this level. The strong faults on which the inclined shaft "D" was sunk to the 200-foot level were encountered in the cross-cut on the 500-foot level, 190 feet north of "A" shaft; drifting along these faults did not reveal any ore of similar character to the rich telluride ore which was found in "D" shaft. Seven diamond-drill holes were made from the 500-foot level. The mine is run by electricity supplied by the Northern Ontario Light and Power Company. W. S. Simpson is manager of the mine.

McElroy Township

Peerless.—The Peerless property comprises a group of claims formerly the Mondoux, located in the west part of McElroy township. The rocks are principally of Keewatin age and are intruded by small masses and dikes of granite. Work has been largely confined to claim 5266, where a strong quartz vein crosses the claim in a N.E.-S.W. direction. The vein would average about six inches in width, but is lenticular in structure. At a point where the vein intersects a N.W.-S.E. granite dike, a shaft has been sunk to a depth of 250 feet. The dike dips steeply to the west anl below the 75-foot level is to the west of the shaft. Exploration has shown a small lens of ore in the vein lying to the west of the granite dike. This ore was opened up by a stope from the 75-foot level to the 50-foot level, and a few tons of ore taken from the workings. Exploration at 125 and 250-foot levels did not reveal ore of a similar character. The ore is of a peculiar type, being brecciated and containing fragments of greenstone and much calcite with the quartz. The ore minerals are native gold, native bismuth, copper pyrites, iron pyrites, galena, zinc blende, pyrrhotite, and a rare mineral containing lead, bismuth and sulphur, which was determined at the Department of Mineralogy, Toronto University, to be cosalite.[1]

Charest.—The Charest claim, L. 5305, is situated in the south-west quarter of McElroy township. As shown on the map the claim is on a small stock of massive, coarse-grained, flesh-coloured hornblende and biotite granite. A quartz vein, averaging about one inch in width and three hundred feet long, strikes 30° north of west across the granite. Considerable fine gold, pyrite, chalcopyrite, and a grey telluride were noticed in different parts of the vein. Other veins on the property contain molybdenite and specular hematite. Some of the veins contain coarse feldspar and are pegmatitic in character, while many of the narrow veins represent the filling of joint cracks. The occurrence of gold in the pegmatitic vein strongly points to the formation of the gold-bearing quartz veins following the pegmatitic veins and representing part of the granite intrusion.

Marsh.—Near the centre of claim No. 4410, McElroy township is an iron formation band striking N.W.-S.E. on which a shaft has been sunk to a depth of eighty feet. Much gossan occurs on the surface, below which are interbanded pyrite and sugary quartz over a width of fifty feet. Across a width of six feet the pyrite is fairly massive. About 100 cubic feet of massive iron pyrites are on the dump.

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[1] Cosalite from Ontario by T. L. Walker, University of Toronto Studies, Geological Series No. 12, 1921.

Irish.—On the central part of claim L. 2581 a 440-foot tunnel has been driven on a white calcite vein which varies from 4 to 8 feet in width. The vein strikes N.E.-S.W. and dips 75° to the south east. A winze has been sunk at a point near the centre of the tunnel.

Near the northern part of the same claim a 35-foot tunnel has also been made on a quartz vein about one foot wide and containing iron pyrites.

Catharine Township

Ten chains east of the northwest corner of lot 9, con. VI, Catharine, there is a quartz vein in volcanic fragmental rocks. The vein strikes N. 75° E. and dips 80° S, showing in places 8 inches in width together with lenses of calcite a foot in width. The quartz carries copper pyrites and has been traced by trenching 50 feet. The same vein has been located four chains to the north-east in McElroy township where some trenching has also been done.

Campbell.—The Campbell property consists of two claims in the north part of lot 12 in the sixth concession of Catharine township. A well defined narrow fracture has been traced by means of trenches from near the northwest corner of the property in a southeasterly direction across the claims. Along the strike several pits have been sunk, revealing narrow, sometimes parallel veins of quartz, averaging one or two inches in width, with the basalt along the veins showing alteration with iron pyrites a few inches from the wall. A small amount of copper pyrites occurs in the veins. Native gold was found in several pits by D. Campbell while samples over a width of four inches, taken by the writers, showed values in gold. The strike of the fracture is roughly that of the volcanic flows of the area.

Cotter.—The property consists of the two south claims in the north half of lot 12, in the sixth concession of Catharine. Trenching has been done on several quartz veins in the west part of the westerly claim and some diamond drilling has been done from the south boundary. The northerly vein, 9 chains north of the south boundary has been trenched for 11 chains. It strikes east and west, dips 60° N. and varies from 2 inches to 2 feet in width. The quartz is narrow, but the wall rock is altered to carbonate and contains iron pyrites and stringers of quartz. A similar but wider vein occurs in the southwest part of the claim, the quartz varying in width from 2 inches to one foot, while the wall rock is altered over a width of 3 feet. No underground work has been done on these veins.

Connell-McDonough (S. ½, lot 12, Concession VI, Catharine township).—The nearly flat vein on the Miller-Independence extends easterly to the Connell-McDonough where there has been considerable trenching along the strike of the vein. Native gold can be observed at several places along the footwall of the vein.

Kennedy-Boston.—The Kennedy-Boston Gold Mines includes the south half of lot 11, con. VI, Catharine township. The rocks are pillow and coarse-grained basic lavas together with narrow bands of felsitic and porphyritic acid rocks with a general N.W.-S.E. strike. A fracture has been traced 1,200 feet on the surface from near the northwest corner to the southeast. It is along the contact of a basic lava, with a light-coloured felsitic or porphyritic rock which lies to the southwest. A shaft, 600 feet from the west line, has been sunk on the fracture, the northeast wall of the shaft being on the contact which is nearly vertical. The mineralization occurs chiefly near the contact. At a depth of 50 feet in the shaft (Sept., 1919), there is reddish greyish silicified vein material carrying pyrite and copper pyrites in fine grains with occasional showings of finely disseminated gold. Two faults, 3½ feet apart, were observed in the shaft to the south of the silicified zone, together with a narrow vein of reddish quartz carrying pyrites. The shaft was later sunk to the 150-foot level and 130 feet of drifting was done northwest and 80 feet southeast of the shaft. A strong fault was encountered 80 feet west of the shaft that displaced the vein to the south.

Catharine Gold.—This property, which is controlled by Geo. and J. Tough, is situated in the north half of lot 10, concession IV, Catharine township. On the north boundary a 12-foot pit is sunk on an altered grey feldspar-porphyry dike about 13 feet wide and striking N.E.-S.W. The porphyry contains a network of quartz stringers some of which carry quite coarse gold showings. Iron pyrites and tourmaline occur in the narrow quartz stringers. The Keewatin pillow lavas adjoining the porphyry are impregnated with carbonate.

Burnand-Gzowski.—The porphyry dike and probably the gold-bearing quartz veinlets which the Catharine Gold is working extend to the adjoining property, the Burnand-Gzowski, which comprises the south half of lot 10 in the fifth concession of Catharine township.

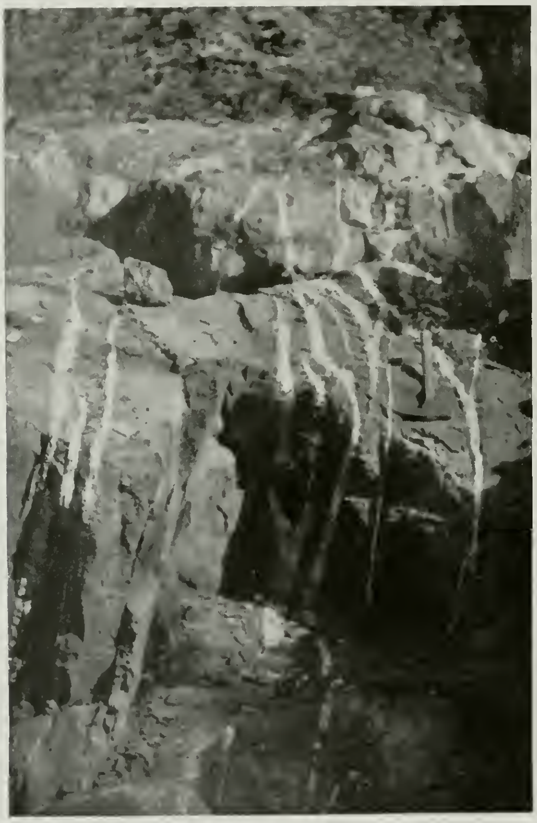
Ostrum (N.W. ¼, N. ½, lot 8, concession III, Catharine township).—Gold to the value of $1 and $2 per ton can be obtained on assay from quartz veins carrying pyrites and calcite in a light-coloured greenstone cut by a narrow quartz-porphyry dike.

Daley.—The claim comprises the S.W ¼ S. ½, lot 6, concession IV, Catharine township. Work has been done on a mineralized zone 250 feet southeasterly from No. 4 post. The rock is rusty weathering carbonate cut by numerous reticulated quartz stringers. The general strike is N. 40° W. and dip 80° N.E. A pit has been sunk to a depth of 12 feet and a long cut made in the mineralized deposit. Iron pyrites occurs abundantly together with some specularite in the deposit.

Walsh-Taylor (N.E. ¼, S. ½, lot 5, concession III, Catharine township).—An inclined shaft has been sunk to a depth of 30 feet on rusty carbonate containing quartz veins. The deposit, which contains considerable iron pyrites and brown and green iron carbonates, strikes 30° south of east and dips about 45° to the northeast. A sample of selected material from the dump yielded $4.80 in gold per ton. During 1921, a rich showing of gold was reported to have been made on the southern part of the claim.

Roger-Barnett.—W. G. Roger and F. Barnett are prospecting a group of claims consisting of the N. ½ lot 5 and the west part of the N. ½ lot 4 in the second concession of Catharine township. The country rock is basalt and diabase with a few narrow feldspar-porphyry dikes. The basalt shows pillow structure and, at times, is spherulitic. In places the basalt and diabase have been replaced by carbonate, a grey rock which is rusty weathering on the surface. Through the altered rock there are a number of quartz veins on most of which work has been done.

The main workings are in the westerly part of the property on lot 5, where a mineralized zone has been trenched in a direction of N. 25° E. for 500 feet. In this zone, which averages 10 feet in width there are numerous stringers of quartz from half an inch to a foot in width running diagonally in a direction N. 18° W. across the altered basalt, now rusty carbonate. The cross stringers of quartz in many places show visible gold, while iron pyrites are present in the quartz and altered rock near the veins. The veinlets are not sufficiently close together in most of the deposit to be mined in one large mass. In one part of the deposit there are irregular quartz veins which are roughly parallel with the general strike, and from these there are narrow quartz veinlets running toward the walls. Some coarse gold was observed in the quartz veinlets. Several pits and cross-cuts have been made on the deposit which generally resembles a stockwork.



Irregular stringers of quartz in rusty weathering altered basalt, Roger-Barnett claim, Catharine township.

A strong quartz vein from 3 to 10 feet wide strikes N.E. and S.W. across the line between 4 and 5. It occurs in the spherulitic lava and, as far as explained, has shown only low gold content.

In the vicinity of this vein some spherulitic lava contains stringers of quartz, while the lava contains spots of iron pyrites. A sample of the mineralized lava showed some gold on assay.

Hounslow.—On the Hounslow location, S. ½, lot 4, concession I, Catharine township, is a deposit quite similar in appearance to the Roger-Barnett. Coarse gold occurs in four quartz stringers. Between each two stringers is about a foot of basalt altering to a grey rusty weathering carbonate. The veins strike north and and south and dip 60° E. About 20 feet east is a parallel vein system in which is a quartz vein 100 feet long and 6 inches in width.

Skead Township

Skead Gold.—Since the spring of 1920, the Skead Gold Mines, Limited has had about 20 men, under the direction of M. L. Bouzan, prospecting 55 mining claims in various parts of Skead township. Encouraging results are being obtained to the west of St. Anthony lake on claims L.S. 29 and L.S. 30 in lot 20 of the second concession. On L.S 29 three shafts have been sunk to depths of 50, 14 and 50 feet on three parallel quartz veins which strike N. 10° E. and dip 60° to 85° easterly. The veins occur in a light grey-coloured andesitic rock which is intruded by an occasional dike of feldspar-porphyry. Some visible gold was found in the central vein near the surface while sinking the shaft. The quartz contains much iron pyrites and, in places, thin seams of molybdenite. Some selected material from the dump at the central vein gave on assay $4.00 in gold per ton.

Narrow quartz vein with stringers of quartz in hanging-wall, Skead Gold property.

In 1921, a number of narrow veins, quite unlike those just described, were discovered on claim L.S. 30 which corners on L.S. 29 to the north-west and extending easterly on claim L7970. These veins, which are roughly parallel in an east-west direction, vary from one inch to twelve inches in width and have been traced 600 feet or more. They carry iron pyrites, copper pyrites and specularite with little or no quartz. From these narrow veins high assays have been obtained varying from $9.00 to $75.00 in gold per ton. The veins, however, are not closely spaced, eight having been found in a width of 250 feet at the time of inspection in October, 1921. The andesite and porphyry adjacent to these narrow sulphide seams have been fractured in places over a width of 8 or 10 inches and the cracks filled with specularite and sulphides. Additional work may reveal wider veins.

A number of pits have been sunk on the veins and a few tons of iron and copper pyrite and specular hematite obtained which were shipped to the provincially owned Timiskaming Testing Laboratory at Cobalt for experimental work. It was found that oil flotation would successfully concentrate the copper after which the gold could be recovered by cyanidation. The higher values appear to come from those specimens which contain considerable pyrite. The company is installing a plant, consisting of boiler, hoist and 4-drill compressor, and intends sinking a shaft and exploring the veins at depth.

On the west side of L.S. 30 a number of pits have been sunk on a quartz vein with strike N.E. and S.W. The quartz is banded and contains iron pyrites, molybdenite, and shows some gold on assay.

The company has also done exploration work on several claims east of St. Anthony lake. On claim 313 an open cut was made on light-coloured felsite carrying iregular stringers of quartz with calcite and a little iron pyrites. On claim 6722, a pit was sunk on stringers of quartz carrying calcite, epidote, red feldspar and iron pyrites. The irregular quartz stringers have a general strike of north and south and occur in diabase.

Telluride Syndicate.—This syndicate has several claims in the south-west part of Skead township. On claim 8846, in lot 2, concession III, a vein with chalcopyrite, iron pyrites and specular hematite, similar to the veins on the Skead-Gold, has been uncovered for a length of 200 feet. The vein strikes N. 60° E., and is from one to three inches in width and shows the presence of considerable gold on analysis.

Nigger (M.R.3.).—This 80 acre claim was surveyed prior to the subdivision of the township of Skead in 1908. The rocks are largely Keewatin dacite and andesite. A few pits have been sunk on narrow N.E.-S.W. bands of iron pyrites containing a little copper pyrites and specular hematite. One such sample gave on assay: silver, none; nickel, none; platinum, none; and gold, $15.60 per ton.

Flanagan.—P. Flanagan has done some development work on several claims in the south part of lot 7, concession III, Skead township, to the east of St Anthony lake; the principal claims are 4927 and 6593. A quartz vein having an east-west strike has been found in a white weathering coarse-grained quartz-diorite porphyry. A shallow pit on claim 4927 exposes a quartz vein 13 inches wide and dipping 80° S. The quartz is somewhat banded and carries fine-grained iron pyrites. A picked sample showed $3.20 gold per ton. The vein, faulted 75 feet to the south, has been followed easterly to claim 6593. At one point it is four feet in width. At the extreme easterly exposure of the vein it is 3 inches wide and carries iron pyrites, copper pyrites, a little galena and a telluride. The vein and quartz-diorite-porphyry are concealed for several chains by a bed of conglomerate of the Cobalt series, 10 feet in thickness. The conglomerate was deposited on the eroded surface of the older rock which carried the vein.

Work has been done by Mr. Flanagan on claim 7675 in lot 4, concession II. Skead township, to the west of St. Anthony lake. A pit was sunk on a quartz vein carrying abundant iron pyrites which occurs along or near the contact of a quartz-porphyry and light-coloured felsitic rock.

On the road west of St. Anthony lake, on claim 8937, in lot 4, concession II, the Flanagan Bros. have uncovered a quartz vein for a length of 150 or more feet in Keewatin felsite. The vein strikes 20° west of north, dips 60° west and varies in width from 2 to 4 feet. Gold can be obtained on panning. One channel sample across 3 feet yielded on assay 60 cents in gold per ton. The quartz is much fractured and contains iron and copper pyrites.

On the Smith-Flanagan claims, L.S. 364 and 365, in lot 6, concessions I and II, Skead township, is a quartz vein from one foot to 6 inches in width and carrying much chalcopyrite. The vein occurs in Keewatin felsite and an intrusive feldspar-porphyry. One sample, on analysis, yielded $5.20 gold per ton.

On claim 7861, immediately south of C.E. 4, in lot 5, concession VI, Skead township, small amounts of gold were reported to have been obtained on analysis from a stockwork of quartz in a red porphyritic hornblende syenite. Small amounts of pyrite, chalcopyrite, galena and green talc were observed.

Fidelity.—The Fidelity property is situated directly northeast of St. Anthony lake in concession IV and V. The north part consists of basic lavas and serpentine with narrow bands of iron formation and dikes of lamprophyre and porphyry.

On claim 238 a shaft has been sunk to a depth of 28 feet on a band of black chert carrying some stringers of quartz with iron pyrites and copper pyrites. Some visible gold was obtained in sinking the shaft. Just north of the shaft the chert band, which strikes N. 10° W., is two feet wide. Cutting the basic lavas and running into the shaft are two lamprophyre dikes 6 inches and one foot in width.

Exploratory work, consisting of stripping and shallow pits, has been done on several bands of iron formation, which consist of contorted layers of silica and magnetite with some hematite. These bands are cut by irregular cross veinlets of quartz in which there is iron pyrites while massive iron pyrites occurs in the iron formation. One band, with strike N. 15° W., from 8 to 20 feet wide crosses the concession line on claims L.S.11 and 6590. Assays have shown the presence of low gold values from several pits. In one pit on claim 463 a lenticular mass of iron pyrites in the iron formation has a width of one foot.

On claim L.S. 11 there is also a mass of light-coloured volcanic rock that is intersected by quartz veinlets. The rock and veinlets carry a little iron pyrites from which assays of two or three dollars have been obtained. Three shallow pits have been made on this mineralized rock.

Barry Webster.—The Webster property is situated in the south half of lot 7, concession V, Skead township. No work was being done at the time of the visit, but some work was found on a narrow band of chert with strike N. 60° W. in the basalt. The chert in places carries streaks of iron pyrites and pyrrhotite on which a shallow pit was sunk. A sample of the mineralized chert showed no gold and a trace of nickel. The owners report that on another part of the property some gold-bearing material was found.

Zenith.—The Zenith Gold property is situated in the northwest corner of Skead township on claim 6202. A shaft was sunk to a depth of 20 feet on a quartz vein, varying from 3 inches to a foot in width, which strikes east and west. The vein occurs in green schist near the contact with a narrow band of porphyry. A. Johnson, in charge, stated that a little visible gold was obtained in the shaft. A pit was sunk on a series of porphyry and lamprophyre dikes striking N. 66° W. on claim 7115. Two porphyry dikes, 2 feet and 3 feet wide, are well mineralized with iron pyrites, but a sample from there showed no gold.

Cook.—The Cook claims, Nos. 3943, 4041, 6743 and 6741, are situated along the boundary between the townships of Hearst and Skead. The rocks consist of bands of rusty weathered carbonate, green schist and sediments intruded by porphyry of which the general strike is N. 35° W. Most work has been done in Hearst township near the boundary line on claim 3943. Here the white weathering porphyry and the rusty carbonate are traversed by numerous stringers of quartz striking N. 38° E. and varying from an inch to a foot in width. The cross stringers are in places connected by other stringers, affording a stockwork structure. The quartz carries in places iron and copper pyrites and the carbonate carries some pyrite near the quartz veinlets. One pit has been sunk eight feet in carbonate. A sample from the pit, across a number of stringers of quartz and carbonate over a width of 4½ feet, was found to carry $6.80 in gold per ton. A selected sample of quartz with sulphides from one vein 4 inches wide showed $14.80 in gold per ton. Several shallow pits have been made along the strike of the carbonate and porphyry for a distance of 100 feet.

Lincoln-Nipissing (C.E. 3.—C.E. 4)—The deposits are stockworks, namely: ferruginous dolomite and porphyry containing considerable pyrite and irregularly cut by quartz veinlets. "Some work has been done on claim C.E.3, consisting of a few cuts, and a shaft, the depth of which was not ascertained owing to the water which it contained when visited" in 1909 by M. E. Wilson.[1] No additional work has been done since 1909.

Manley-O'Reilly.—A specular visible gold showing was made in the autumn of 1919 by Walter Manley on the Manley-O'Reilly claim L.S. 128, lot 6, concession VI, Skead township. Considerable gold in very fine particles occurs on a slickensided contact between quartz-porphyry and a narrow band of greenish carbonate carrying numerous cubes of iron pyrites and some serpentine and quartz particles. Some gold also occurs in seams in the green carbonate distant a few inches from the gold-bearing contact. Two similar carbonate bands, 6 inches in width, lie a few feet northeast of the gold-bearing carbonate. The 12-foot quartz-feldspar-porphyry dike and ferruginous dolomite adjoining the gold showing are intersected by numerous quartz veinlets which carry some iron pyrites and a little galena. A similar assemblage of porphyry, quartz and green carbonate bands occur along the same strike across a clay flat 200 yards to the southeast. A diamond-drilling programme is outlined for 1922.

Martin.—In the southwest corner of the Martin claim, No. 6263 on lot 9, concession VI, Skead township, is a cylindrical mass of porphyry about 100 feet in diameter and apparently surrounded by Keewatin pillow lava. The porphyry contains a network of quartz veinlets and lenses of quartz up to several feet in width carrying much pyrite and some galena. Visible gold was reported to have been found. A chipped sample across 20 feet yielded 40 cents in gold to the ton. The work comprised a shaft and some open cuts.

Crawford-Skead.—The Crawford-Skead property consists of two claims in the north parts of lots 9 and 10, concession V, Skead. A shaft has been sunk to a depth of 22 feet on the contact of red porphyry and lamprophyre. Along the contact there is a silicified zone which carries abundant fine-grained iron pyrites for a width of 26 inches at the east end of the shaft. Some molybdenite occurs along slickensided fractures in the quartz. The porphyry near the contact also carries abundant iron pyrites. A sample 26 inches wide of silicified material, with pyrite lying between porphyry and lamprophyre, gave 40 cents in gold per ton. The general country rock is an altered sediment.

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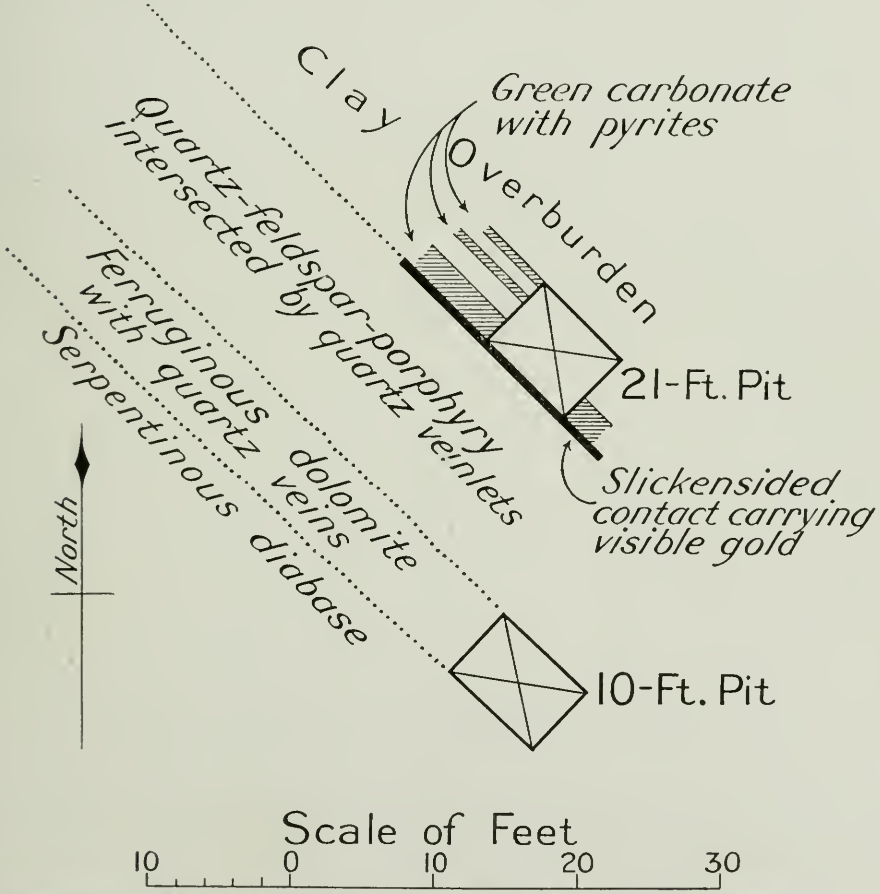
[1] Geol. Sur. Canada, Memoir 17 E., p. 55.

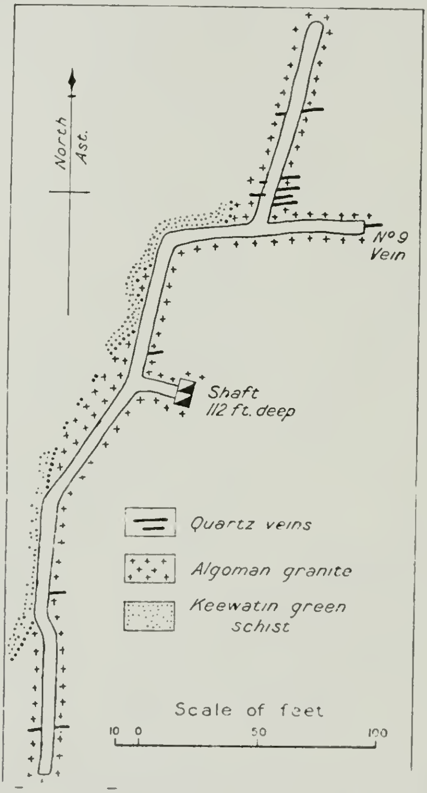
Wisconsin-Skead (Claims Nos. 4352, 4353, 4354, and 4406 on lot 10, concessions V. and VI., Skead township).—Crossing these claims in a northwest-southeast direction is a massive pink biotite granite, porphyritic in places and about 400 feet in width with Keewatin greenstone and Timiskamian sediments on the sides. Crossing the granite dike at right angles to its longer dimension on claim 4353, where practically all development work has been done, are numerous parallel quartz veins which all dip about 40° south. These veins are usually an inch or so in width, although veins Nos. 6 and 11 are approximately 3 and 6 feet wide respectively, and contain some visible gold and a telluride. No vein was seen extending from the granite into the adjoining wall rocks. A shaft has been sunk vertically in the granite to a depth of 112 feet exposing numerous quartz veinlets dipping about 40° south. On the 110-foot level about 1,000 feet of lateral work has been done. No. 6 vein occurs along a fault which contains quartz, calcite, pink barite, pyrite, molybdenite, gold and a telluride. The No. 11 vein had not been reached in the cross-cut when the workings were examined in March, 1920. In May, 1921, the shaft was full of water. Much diamond-drilling has also been done. The property has been cleared of the forest; a steam compressor and good


Clay
Green carbonate with pyrites
Overburden
Quartz-feldspar-porphyry intersected by quartz veinlets
Ferruginous dolomite with quartz veins
Serpentinous diabase
21-Ft. Pit
Slickensided contact carrying visible gold
10-Ft. Pit
North
Scale of Feet
10
0
10
20
30

Sketch showing the geology in the vicinity of the Manley-O'Reilly gold discovery.

buildings have been erected. The company intends obtaining hydro-electric power from the Raven Falls power plant, for further development.

Sampson (Claims Nos. 4363 and 4364 on lot 10, concession VI, Skead township).—These claims lie directly north of the Wisconsin-Skead. Work consists of trenching and test-pitting. Gold has been found in a stockwork of porphyry and quartz up to 100 feet in width. The quartz veins vary in width from 3 feet to a fraction of an inch in thickness and carry pyrite, molybdenite, telluride and gold. A grab sample, from a seam 4 inches wide and containing much pyrite, molybdenite and molybdite, assayed $14.80 in gold per ton.



Plan of 100-foot level. Wisconsin-Skead property, March, 1920.
Most of the veins dip from 30° to 45° south.

De Villiers-McBurke.—Gold was reported to have been found on May 17th, 1921, on the northwest corner of Rattray township on the unsurveyed claim No. 9168. The vein was examined two days later, but the owners had no gold that could be seen in place. The vein is composed of glassy quartz, occasionally smoky in character and containing a little pyrite and galena. In places considerable rusty carbonate is interbanded with the quartz. The vein had been uncovered, at intervals, for 1,700 feet in a north and south direction. The vein is 10 feet wide in places and apparently dips 85° to the west. The enclosing rocks are Timiskamian greywacké schists impregnated with pyrite, and quartz-porphyry.

Gold is reported to have been found on various other locations in Skead township. They are as follows: Mutton (claim No 6711 in lot 4, concession III); Kearney (L.S. 214); Gorman (6830) and Boughmam (5004), the last three claims being the north parts of lots 7 and 8, concession V.

THE BLACK RIVER AREA

By D. G. H. Wright

Introduction

The following report, based on information obtained during a survey in the field season of 1920, deals with the geology and economic possibilities of an area in the District of Timiskaming, north of and contiguous to the Kirkland Lake[1] area and west of the Ben Nevis area[2]. The character and age of the rocks in the area were known in a general way to be similar to those in the adjoining townships already geologically surveyed. Little detailed information, as to character of the country, geology, economic possibilities or travel routes, had been collected.

With such limited time available for the work—nine townships, approximately 325 square miles being covered in the season—detailed examination was neither attempted nor possible. For this reason the report must be considered as presenting only the geological generalities, supplemented by more detailed work in parts where considerable staking had been done or rock formations warranted it.

The mapping of the lakes and rivers was done by means of a split-objective lens micrometer and prismatic compass, using the various township boundaries as control. Closed traverses were made wherever possible. The inland traverses were made by pacing and compass methods and small lakes intercepted on these traverses were sketched by taking compass bearings on prominent points and estimating the distances.

Acknowledgments

The writer was efficiently assisted in the field by E. Howell, D. E. Kerr-Lawson and R. Presgrave.

The photomicrographs were kindly prepared by C. W. Knight, to whom thanks are also due for many suggestions as to the geological mapping of the area and assistance in the compilation of this report.

The preparation of the geological maps and inserts accompanying this report was done by P. A. Jackson under the supervision of W. R. Rogers, topographer of the Ontario Department of Mines.

The chemical analyses and assays were made by W. K. McNeill and T. E. Rothwell of the Provincial Assay Office.

Thanks are due to many prospectors who tendered much information which aided materially in the field work. It is particularly desired to thank V. Woollings of Thos. S. Woollings Co., Ltd., for many courtesies shown the party while in Black township and vicinity.

Thanks are also due H. George Ginn, Mining Recorder, Swastika, for blue prints and information provided.

Maps

The report is accompanied by a geological map, No. 30c, scale one mile to the inch. In the general arrangement of the map, the plan, initiated by C. W. Knight in his map of the Ben Nevis area,[3] has been followed, the dotted lines showing the country traversed in the section work. As most of the lakes and rivers of the area had not been surveyed previously, much of the time spent in the field was occupied in topographical work.

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[1] Kirkland Lake Gold Area, Ont. Dept. Mines Report, Vol. 29, Part IV, 1920; **also Vol. 23, Part II.**

[2] Ont. Dept. Mines, Vol. 29, 1920, Part III, Ben Nevis Gold Area.

[3] Map No. 29*c*, accompanying Ont. Dept. Mines Report, Vol. 29, 1920., Part III.

The following maps have been utilized in the preparation of the map of the Black River Area:

(1) The eastern boundary of Bisley and Morrissette township taken from map No. 29 e, Ben Nevis gold area, by C. W. Knight, Ontario Dept. of Mines Report, 1920, Vol. 29, Part III.

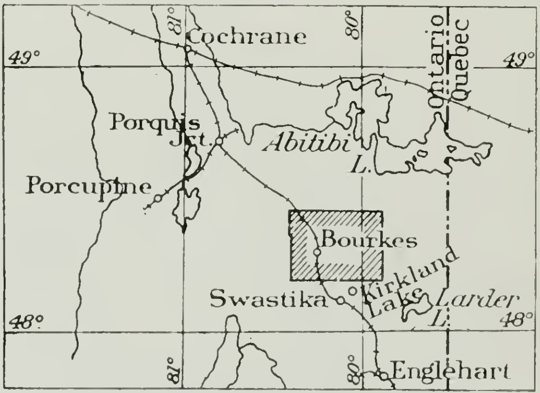
(2) The Goodfish Lake Area taken from map No. 25 f. by A. G. Burrows and P. E. Hopkins, Ontario Bureau of Mines Report, 1916, Vol. 25, part I.

(3) The southern boundary of Bernhardt and Morrissette from map of Kirkland Lake and Swastika Gold Areas by A. G. Burrows and P. E. Hopkins, Ontario Bureau of Mines Report, 1913, Vol. 23, part II.

(4) The township of Maisonville extracted *in toto* from map No. 23b, by A. G. Burrows and P. E. Hopkins, Ontario Bureau of Mines Report, 1914, Vol. 23, part II.

(5) The northern boundary of Barnet and Thackeray townships from map No. 28b, accompanying Ontario Bureau of Mines Report 1919, Vol. 28, part II.

(6) Topographical features of Lee township were largely supplied by S. Woollings, who has timber cruised this township.



Scale, 50 Miles to 1 Inch.

Index map showing location of the Black River Area (hatched) in relation to Porcupine and Kirkland Lake.

Location

The area described comprises the following townships; Cook, Barnet, Thackeray, Bisley, Melba, Benoit, Black, Lee, Bernhardt and Morrissette. Since all of this area with the exception of the southern portion of Bernhardt and Morrissette is drained by the Black river and its tributaries, it has been named for the purposes of this report "The Black River Area." The position of the area with respect to adjacent localities is indicated in the accompanying index map. Black river is a tributary of the Abitibi, and joins the latter in the township of Walker at a point about six miles east of Porquis Junction on the T. and N.O. railway.

Accessibility

The western portion is traversed by the Temiskaming and Northern Ontario Railroad. The southeastern part is best reached by way of Swastika from thence by stage to Kirkland lake; by canoe route from Kirkland lake, Bernhardt and the southwest portion of Morrissette township is accessible.

White Clay and Woollings creeks, which empty into Meyers lake, make the interior of Lee and Black townships, accessible by canoe. White Clay creek is not navigable in low water, and even in high water navigation is made difficult by the swamp alders which overhang the banks. Canoe travel on Woollings creek was possible even during the dry season experienced in the summer of 1920. A canoe route, free from portages, leads to Meyers lake from Bourkes on the T. and N.O. railway. From Bourkes the route follows the White Clay river, traverses Lower Twin and Swan lakes and then follows White Clay creek northward into Meyers lake.

The balance of the area is accessible from Scotties Springs,[1] a flag station on the Temiskaming and Northern Ontario railroad, at a point where the Black river parallels the railroad about five miles north of Bourkes. The Black river is navigable with little difficulty into Morrissette township. More will appear under the various townships regarding their respective accessibility.

Early Prospecting and Historic Notes

Shortly after the discovery of the silver bearing veins at Cobalt in 1903 this area was prospected for silver, and old workings were met with in various places, but particularly in Benoit, Black and Barnet townships.

In 1912 gold discoveries were made in the vicinity of Goodfish Lake. In 1916 discoveries of gold promising to be of economic importance, were made in the vicinity of Bourkes by A. Skjonsbye, Oscar Anderson, A. Wickstead, and others. These two localities are still promising and contain many prospects which require more development before any pronouncements can be made as to their economic value.

Thackeray township also boasts of its gold rush, and considerable prospecting was done by the Howey brothers, D. Willans, W. Cochenour and others, but no spectacular finds were made. As a result nothing further has been done in this locality.

The finding of a flint arrowhead on the north shore of Splashwater Lake, in Bernhardt township, caused the writer to inquire into the early Indian occupation of this area, as it was not thought that the Indians penetrated so far inland from recognized travel routes in arrowhead days. Dr. R. B. Orr,[2] when questioned relative to the early Indian occupation, volunteered the information that this area was occupied by Algonquin tribes, chiefly by the Abitibi, as early as the 17th century. Historical records tell of an expedition of the Iroquois sometime in the 17th century as far as Iroquois Falls, where they met and defeated the Abitibi. Shortly after the French occupation the Abitibi discontinued the manufacture of flint artifacts, as they readily accustomed themselves to new conditions. The finding of the arrowhead, above referred to, points to Indians penetrating even this remote part of our Province prior to the French occupation.

Previous Geological Work

The only previous geological work accomplished in the area, other than along some of the township boundaries done in conjunction with the work in adjacent areas, was that of A. G. Burrows[3] in the vicinity of Bourkes, and that of A. G. Burrows and P. E. Hopkins, in the Goodfish Lake Gold Area.[4]

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[1] Since called Yorkston station, Scotties Springs P.O.

[2] Director Provincial Museum, Normal School Bldg., Toronto.

[3] Gold Bearing Veins of Benoit Township, Ont. Bur. Mines Report, Vol. 26, 1917, pp. 248-251.

[4] Goodfish Lake Gold Area, Ont. Bur. Mines Report, Vol. 25, pp. 260-263.

Topography and Physiography

The Black River area saddles the divide between the Hudson Bay slope and the drainage basin of the St. Lawrence river. The greater portion lies to the north of this height of land. The area has an average elevation of 1000 ft. above sea level with hills and ridges rising here and there to elevations seldom in excess of 350 feet above the surrounding country. A bench mark about one quarter of a mile north of Bourkes on the Temiskaming and Northern Ontario railroad records an elevation of 1011.92 feet. Goodfish lake is approximately 1025 feet above sea level.

The principal points of high elevation in the area consist of volcanics of the Keewatin series. Practically the only exceptions are ridges of the Cobalt series, which may be seen in the southwest of Benoit township and also in Black township. The high, hump-shaped, northern outlier of the Cobalt series—Defiance Peak—west of Butler lake is a typical example. The highest hill in the area is possibly the one rising to a height of 350 feet above the surrounding country situated one mile north of the southwest corner of Cook township. Lava Flow mountain, in lots nine and ten in the fifth concession of Cook township, is approximately 175 feet in height. It has the outline of an old volcanic cone. From Blue mountain which rises 200 feet in the northwest of Bernhardt, and also from the east to west ridge rising 150 feet with a precipitous face northward situated immediately south of the northwest corner of Melba township, commanding views of the surrounding country may be had. A wonderful view of the country stretching to the north, west and east for fifteen to twenty miles may be obtained from the last mentioned mountain. There are many other localities possessing prominent peaks, for example the central portion of Morrissette, the area southwest of Columbus lake in the same township and along the line between Bisley and Melba townships northward from the Black river which consists of a series of peaks from which one may view for miles the landscape typical of the Laurentian plateau region, spruce covered for the most part, but here and there dotted with patches of poplar and birch.

Looking north at "Lava Flow" mountain, Cook township.

The area in common with all of the Laurentian plateau country has many lakes. These occur chiefly in the rocky, hilly country, particularly in Bernhardt and Black townships.

Amikougami lake is remarkable for its irregular shape, high rocky shores, numerous arms and islands, and the extent of its shore line. The series of lakes lying north of Goodfish lake, east of the western boundary of Morrissette, being in sandy country are all remarkably clear and largely spring fed. Butler, Malloch and Verona lakes are sand bottomed and crystal clear. The first two named vary in depth from 20 to 40 feet. Soundings of 150 feet were obtained in Verona lake. The only other lake of outstanding features is Lauramay, situated in the southwest corner of Bisley township. Next to Amikougami it is the largest lake in the area, being about one and a half miles long from east to west and one half mile wide. It is dotted with rocky islands and surrounded on all sides by high hilly country, all of which make quite a picturesque setting. The other lakes of the area are for the most part shallow, weedy-edged bodies of murky water containing a considerable amount of organic matter in suspension.

High falls, Melba township, a series of cascades with a total drop of upwards of one hundred feet. The picture was taken from hilltop at foot of falls.

The Black river is the only stream of importance. Its source is south of the centre of Morrissette township, and it follows a sinuous course through swamp-land northward into Bisley township where its banks become higher as it flows through the clay land; then in a general westerly direction it meanders across Melba township into Benoit and Cook, where it broadens into a stream two to three chains wide with a depth of ten to fifteen feet, after its two main tributaries, the White Clay and the Little Black, have augmented its flow. The other streams and creeks of the area are neither wide nor deep and the largest of them are only navigable in the early summer or during a wet season.

Waterfalls

The area possesses several waterfalls, the principal one being High falls, situated on the Black river about the centre of Melba township. The total drop including the rapids at the foot of the falls approaches 100 feet and is made up of a series of cascades from eight to twenty five feet each. In June the volume of water passing over was not large, but a storage dam might make the falls worth harnessing for power purposes. Three other waterfalls of from 20 to 30 feet exist, one on the White Clay river in Benoit township about 30 chains east of mileage 185.5 on the Temiskaming and Northern Ontario railroad, another on the Little Black river in the northwest corner of Bernhardt and the other in the centre of Lee township on the creek which drains into the southwest of Meyers lake.

Glaciation

The effects of glaciation are noted everywhere throughout the region. Huge boulders have been left on the summit of the highest peaks. The processes of denudation and deposition resultant from the Labradorian ice sheet have created a youthful drainage system on a surface of low relief, producing the peculiar glacial physiography so typical of the pre-Cambrian Shield. The sand ridges of the region do not follow any general direction. For instance along the southern boundary of Thackeray the ridges run from north to south; in Cook township several prominent ridges have a northeast to southwest trend, and in the northwest corner of Black township, the alignment is from east to west.

A rather striking feature was noted in Cook township. On the slopes of Lava Flow mountain are terraces suggestive of ancient beaches. The boulders and pebbles are in step-like formation and there is an indication of sorting.

Fish and Game

Generally speaking fish are not plentiful throughout the area. The lakes of Bernhardt township are the most productive. Pickerel, pike, and whitefish are the most plentiful species. There are also a great number of suckers and white trout which are of little commercial value. The large amount of suspended material, both clay and organic matter, in nearly all of the lakes and streams make them an unsuitable environment for either trout or bass, but even in the lakes already referred to as having clear water these two species, which might be expected, are absent. The only fish in Butler lake, for example, were perch, and these rarely of edible size.

Moose were plentiful in the district particularly along the Black river in Melba township. A few red deer and caribou are reported to frequent Black and Lee townships. The intense trapping of the beaver during the recent open season has nearly exterminated this species. Only a few fresh beaver cuttings were seen by the party. The mink, the fox, the fisher, the lynx, the muskrat, the rabbit and the black bear are all inhabitants of this area, but are not numerous.

Ducks were not plentiful; each lake, however, had a few. Partridge were especially abundant.

Forests and Forest Fires

The forests are nearly all green, practically the only large belt of brulé being in Cook and Barnet townships which were swept by the Matheson fire in 1916. The northwest corner of Black township is all old brulé. The only fire of any size in 1920 swept along the Woollings camp road to the south of Malloch lake and crossed into Benoit township. No timber of merchantable size was lost in the fire.

The forest growth varies locally, the character of the country being the determining factor. Poplar, birch and balm of gilead border streams and lakes and timber the slopes or other areas where the drainage is good. The sand covered areas are timbered with jack (Banksian) pine. The low, poorly drained, clayey soil produces a black spruce forest which if very wet has a fair percentage of tamarack. In rocky areas, a mixed forest growth of red, white and jack pine with considerable birch, poplar and black spruce exists. The low muskeg areas are, covered with scrub spruce and tamarack. Cedar has not an extensive distribution in the area, only two localities of importance were noted, one in the northwest quarter of Black township and the other in Cook township.

Economically, the only trees of importance are the black spruce and poplar and these species are the most plentiful in the region. Spruce and poplar for pulpwood was being cut in Black, Lee, Benoit and Cook townships in 1920. The balance of the area possesses large reserves of these woods, which, as they become more accessible will provide a supply for the ever growing pulpwood industry. The jack pine in some localities grows straight and tall with a diameter of twelve to eighteen inches. In the vicinity of Malloch lake one jack pine having a girth of seventy odd inches, was cut for exhibition purposes. The year rings numbered 167 approximately. Doubtless much of the jack pine will some day be of commercial value for rough lumber, lathes or railway ties.

General Geology

The Black River area geologically is pre-Cambrian, the dominant rocks being basic lavas of Keewatin age.

Below is given the classification of the rocks and unconsolidated material referred to in the report and on the accompanying map, according to their relative ages. The oldest rocks are at the bottom of the table.

PLEISTOCENE.

GLACIAL AND RECENT:
Boulder clay, stratified clay, sand gravel, peat.

Unconformity

PRE-CAMBRIAN

KEWEENAWAN:
Diabase and gabbro.

Intrusive Contact

COBALT SERIES:
Conglomerate, arkose, greywacké, slate-like greywacké.

Unconformity

ALGOMAN:
Granite, syenite, grano-diorite, red and grey feldspar-porphyry, quartz-porphyry.

Intrusive Contact

PRE-ALGOMAN (HAILEYBURIAN):
Diabase and lamprophyre dikes and boss-like masses which intrude the Keewatin but the relationship to the Timiskaming series is unknown.

Intrusive Contact

TIMISKAMING SERIES:
Conglomerate, quartzite, greywacké and schistose derivatives, some of which may be Keewatin.

Unconformity

KEEWATIN:
Basic to acid rocks including basalt, diabase, andesite; grey, pillow and amygdaloidal lavas; tuffs and volcanic fragmental rocks.

Keewatin

Prior to the spring of 1918 geological investigation had not revealed the structure of the Keewatin series of Ontario. The Keewatin was regarded as a complex of igneous rocks of volcanic origin, devoid of regular geological sequence. In 1918 members of the staff of the Ontario Department of Mines [1] discovered and worked out an orderly succession of lava flows in Holloway township, comprising 14 distinct flows with a combined thickness of 4,400 feet. These flows have aided materially in giving a true conception of the Keewatin series.

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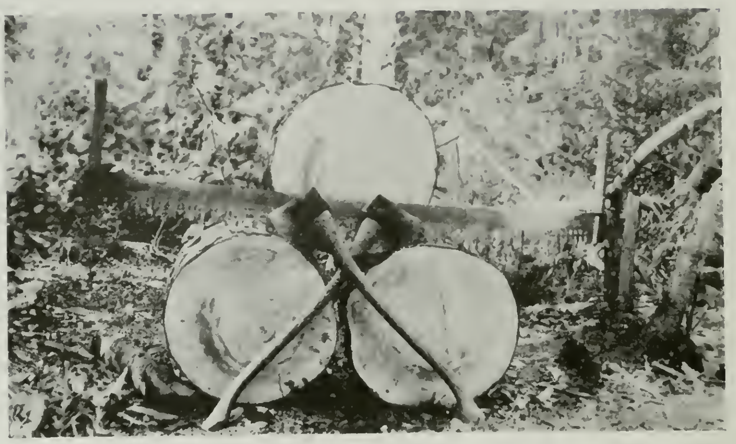
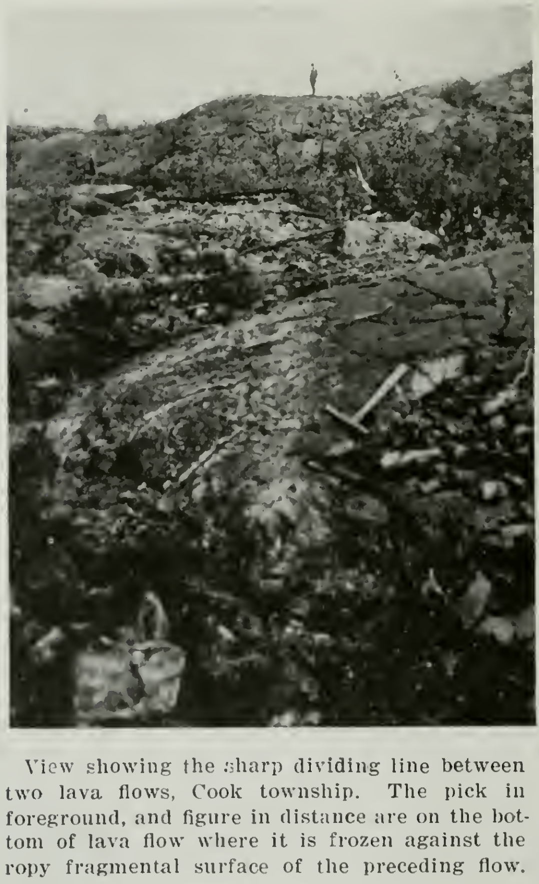
[1] Abitibi-Night Hawk Gold Area, Ont. Bur. Mines, Vol. 28, Part II.



Jack pine cut for exhibition purposes from Malloch lake, Black township. The girth is seventy odd inches and the year rings, roughly counted, numbered 167.

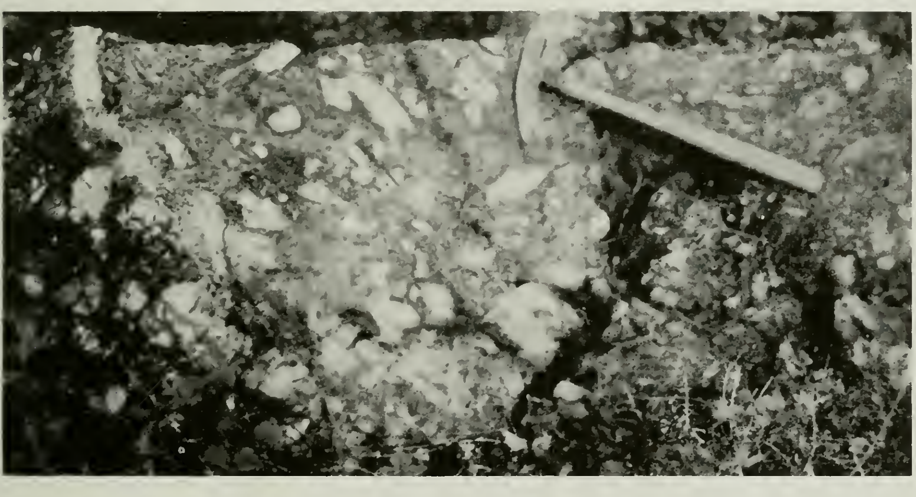


View showing the sharp dividing line between two lava flows, Cook township. The pick in foreground, and figure in distance are on the bottom of lava flow where it is frozen against the ropy fragmental surface of the preceding flow.

That the Holloway township lava flows are not merely a local structure in the Keewatin is substantiated by the fact that a similar succession of lava flows were found in Cook township about twenty-two miles west of Holloway, during our work in the summer of 1920. As the Cook township flows are considered typical of the Keewatin series of the Black River area, no unnecessary details of petrographic description will be given here. Suffice it to say that the rocks of the Keewatin series in this region are similar to those of like series in northern Ontario and Quebec already fully described by W. G. Miller, C. W. Knight, A. G. Burrows, W. H. Collins, M. E. Wilson and others.

Keewatin Lava Flows, Cook Township

The Cook township flows are located in the north half of lots eight, nine, and ten in the fourth concession, and lots seven, eight, nine, ten and eleven in the fifth concession of Cook township. The north to south section traversing these flows was run from the north half of lot ten in the fifth concession to the north half lot ten in the fourth concession, along a line a few chains east of the lot line.



Fragmental top of lava flow, Cook township.

The locality is accessible by canoe from Scotties Springs. The Black river is followed down stream for about two miles to the mouth of the creek outlet of Bolton lake. This creek is followed to Bolton lake; then the lake crossed to the northeast extremity where a small creek has its inlet. This creek is followed a short distance to the line between concessions three and four which is travelled to the southwest corner of lot ten in the fourth concession. The lot line is then taken northward for forty-six chains. To the north and east of this point are the lava flows.

A brief resumé of the principal lava flows of the world ranging in age from Pre-Cambrian to geologically recent, was given by C. W. Knight,[1] in connection with his description of the Holloway township flows and the reader's attention is directed to this report for a better understanding of the following detailed discussion of the Cook township lava flows.

The belief of the most eminent geologists is that fissure eruptions (both the Holloway and Cook townships flows are classed in this type) played a more important role in the formation of lava flows than did the volcanoes. The absence of volcanic necks in areas where vast and ponderous sheets of lava appear furnishes a basis for the theory of fissure origin.

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[1] Ont. Bur. Mines Report, Vol. 28, 1919, Part II, pp. 17-19.

The Cook township lava flows as worked out, have a total thickness of 7,300 feet and comprise at least fourteen distinct flows, or the same number as in the township of Holloway. More detailed work may reveal the presence of even more, for it was noted that the ropy fragmental tops of the flows disintegrated more readily under weathering processes and hence it may be surmised that the drift covered areas are more likely to conceal a flow top, than a flow centre. It is not desired to give the impression that these flows are local, for throughout the Black River area there is a widespread distribution of pillow lavas, amygdaloidal basalts, and other rocks possessing the specific characteristics of lava flows. For this reason it is thought that the Keewatin formation in the entire Black River area represents a succession of lava flows, the structure of which is at present obscure, owing to the overburden. The locality of the Cook township lava flows has been burned over, and thus the rocks are laid bare revealing the structure in a remarkable manner. The flows have been tilted up from a horizontal position to one approaching the vertical. The upturned edges of the flows have an average strike of north 83° east astronomic, and a dip to the north of 80°.[1]

An interesting fact about the strike of these flows is that a continuation of their line of strike would approximately join the Holloway lava flows.

The lateral (east to west) extent of the flows was not worked out owing to the limited time at our disposal. A section near the southern limit of the exposure was run eastward from the line between lots ten and eleven for one and a quarter miles along the dividing line between the top of one flow and the bottom of the succeeding flow. The dividing line was continuous and well marked throughout, except, of course, where it was concealed by drift. Along the foregoing section several dikes were observed to cut the lava flows. The location of three of these dikes is given below:

(a) 600 feet east of the lot line a diabase dike 40 feet wide, striking N. 40 E. magnetic.

(b) 2950 feet east of the lot line diorite porphyry dike 10 feet wide striking N.W. approximately.

(c) 5500 feet east of the lot line numerous gabbro dikes cut the flows for 100 feet of their lateral extent.

Before proceeding with a description of these flows it is deemed advisable to explain the scope of some of the various terms used. The term basalt includes the dense basic igneous rocks of a green color. The term "grey lava"[2] refers to those grey coloured, fine-grained lavas which may have an intermediate composition between rhyolites on the one hand and basalts on the other.

It is highly probable that other rocks are included in these two classes such as trachytes, dacites, quartz-porphyries and andesites, but for the purpose of this discussion the foregoing broad classification will suffice.

In the brief summary of the flows which is given below the oldest is No. 1, and occurs at the northern extremity of the outcrop; proceeding south younger and still younger flows are met with.

Flow No. 1.—This flow is the most northerly worked out, although indications of distinct flow structures were observed north of this point on the west boundary of the township. The flow has an exposed thickness of 350 feet. The bottom is not discernible because at the northern exposed limit, the basalt, which is the characteristic rock of the bottom and central portions of the flows, disappears in a spruce swamp. The top has a thickness of 30 feet comprising ropy, slaggy, fragmental material in which incipient pillow structure is developed.

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[1] The Holloway township flows dip to the south 80 deg. and strike a few degrees south of west, astronomic.—Ont. Bur. Mines Report, Vol. 28, Part II, p. 10.

[2] C. W. Knight, Ont. Bur. of Mines Report, Vol. 29, Part III, p. 20.

Flow No. 2.—This flow has a depth of 875 feet, and may possibly include more than one flow, as part of it is drift covered. The ropy fragmental top is but 10 feet thick which tends to confirm this conjecture. Two shear zones which have been infiltrated with quartz and calcite exist near its base and test pits have been sunk on these but apparently they failed to reveal minerals of economic importance. This flow has a porphyritic development running in bands, almost dike like, one 20 feet and another 160 feet from the surface. The porphyritic bands are each 20 feet wide.

Flow No. 3.—This is a thin flow of 60 feet having a 25 foot top of ropy, volcanic, fragmental material. At the base the flow has a porphyritic texture, but the phenocrysts are not as plentiful as in the preceding flow.

Flow No. 4.—This flow has an apparent total thickness of 635 feet, a 30 foot ropy, fragmental top, and below this a development of pillow structure for about 300 feet. Another belt of pillow lava is developed to 100 feet from the bottom. A porphyritic texture is assumed ten feet from the bottom. The plagioclase feldspar phenocrysts are sparsely scattered through a basaltic ground mass.

Flow No. 5.—The depth of flow No. 5. is 500 feet of which 35 feet constitutes a top of volcanic fragmental material possessing a ropy and incipient pillow lava structure. Below the top for two hundred feet pillow lava structure is developed, and then basalt, assuming towards the centre a granitoid to diabasic texture.

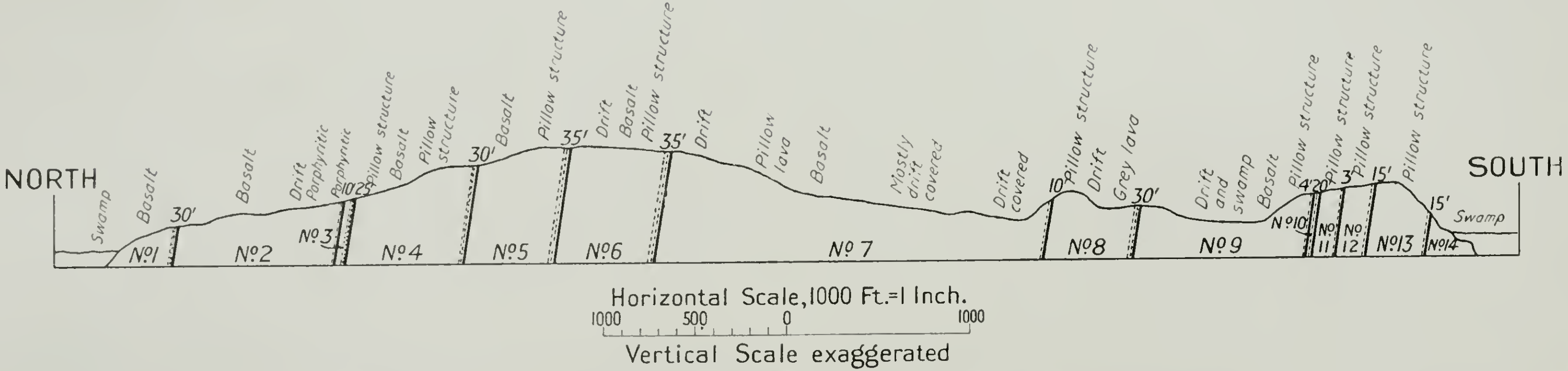
Flow No. 6.—This flow has a 40 foot top of ropy, fragmental material and a total thickness of 540 feet. As 150 feet of this is drift covered, there is a possiblity that this may comprise more than one flow. Below the ropy surface to a depth of 200 feet there is a wonderful development of pillow structure. Many of the pillows show a concentric structure of alternate bands of spherulites and basalt. Where it is frozen against the top of flow No. 5 there is a 10-foot belt of pillow lava.

Flow No. 7.—Drift, sand, and swamp cover this flow in various places and consequently it is possible that more than one flow is included. The apparent thickness is 2120 feet. The thickness of the possible top is only 10 feet, a fact which would point to a thin rather than a thick flow. About the centre of this flow there exists a shear zone 10 feet wide. Here the basalt has become quite schistose and much altered. In places the flow becomes less basic, resembling a grey lava with flow lines.

Flow No. 8.—The total thickness of this flow is 490 feet. The surface extends to a depth of 30 feet and consists of volcanic fragmental material having slag-like inclusions and showing the usual ropy, incipient pillow lava structure. Below the surface is a belt 125 feet thick of grey lava. Surfacing the ropy top of this flow is a 15 inch band of light green chert-like rock which shows distinct bedding. This is probably a silicified tuff, as under the microscope a thin section shows it to be an aggregate of fine angular particles. This tuff may have settled through the condensation of water vapors which in all probability would be quite dense during an outpouring of lava such as this, or it may denote a sub-aqueous desposition. The narrow belt of silicified tuff is not continuous and caps the flow for only a little over a hundred feet.

Flow No. 9.—This flow has an apparent thickness of 930 feet but as 700 feet of this is covered with sand and swamp it is impossible to state definitely that this thickness comprises but one outpouring of lava. There is only 4 feet of ropy fragmental top indicative of a thinner flow.

Flow No. 10.—This flow was only considered as a possible one owing to the fact that there was a depth of but ten feet of amygdaloidal basalt topped with



VERTICAL SECTION THROUGH COOK TOWNSHIP LAVA FLOWS, SHOWING 14 BASALTIC LAVA FLOWS.

Heavy lines denote contact between lava flows. The flows are numbered 1 to 14, commencing at the north end. The numbers 30, 10, 25, etc., denote the thickness of the fragmental top. The oldest flows are at the north, successively younger flows occurring to the south.

a thickness of fifteen feet of ropy, volcanic fragmental material. No pillow lava structure was observed.

Flow No. 11.—This flow has a total thickness of 120 feet and a ropy surface to a depth of 3 feet. No pillow lava structure was observed.

Flow No. 12.—This flow has a total thickness of 165 feet and a 15 foot top of ropy, fragmental material. No pillow structure was seen, other than the incipient pillow structure characteristic of the tops of all the flows observed. The bottom of the flow, like its predecessors, is basalt grading to a gabbro near the centre of the flow.

Flow No. 13.—This flow has a thickness of 310 feet, 15 feet of which constitutes the volcanic fragmental top. The flow has a considerable thickness of pillow lava. The pillows show a concentric structure of basalt alternating with spherulites. Eighty feet from the surface of the flow is a layer of porphyritic lava containing phenocrysts ranging in size up to three quarters of an inch in diameter. The phenocrysts weather white, producing a leopard-like appearance.

Flow No. 14.—Only 20 feet of the basaltic bottom of this flow is exposed before the outcrop disappears in a swamp.

Description of Bottom of Flows

The immediate bottom of the flows is a basalt, fresh and fine-grained resembling a devitrified glass where it is frozen against the top of the underlying flow. As the centre is approached the texture becomes coarser, until a coarse granitoid texture is reached. Just below the ropy fragmental top, the basalt, gabbro or diabase becomes quite amygdaloidal. In nearly every flow the amygdaloidal facies was observed below the fragmental surface.

The flows show little effects of dynamic metamorphism although they have been tilted into a nearly vertical position. In consequence they retain their massive character and are rarely altered to schists.

A thin section was made from a specimen taken from the centre of flow No. 4, which, under the microscope, revealed a remarkably fresh rock possessing ophitic or diabasic texture. The usual decomposition products such as chlorite were present. No primary quartz[1] was observed.

Description of Top of Flows

The surface of the flows is made up of angular, stony to sub-vitreous fragments of lava varying from a few inches to a fraction of an inch in width. Fragments of a peculiar, quite porous, bluish-black slag-like material, may be observed in the surface of these flows. This material is rarely angular in shape. Other fragments are of amygdaloidal basalt.

An analysis of the peculiar bluish black, slag-like material was made. It will be observed from the results tabulated below that chemically it corresponds with the average basalt:

	SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	CO_2	H_2O	XyO
A.	48.64	14.81	6.02	9.78	7.28	4.56	4.10	1.72	0.88	2.18	....
B.	51.9	15.3	3.1	3.6	7.4	8.7	2.5	3.3	....	2.5	1.7
C.	48.76	15.89	6.04	4.56	8.15	5.98	2.93	3.43	....	1.88	2.61

A.—Bluish black slag-like material from Cook township Lava Flows.
B.—Basalt—Pirsson; Rocks and Rock Minerals, page 225.
C.—Basalt—Reis & Watson; Engineering Geology, page 89.

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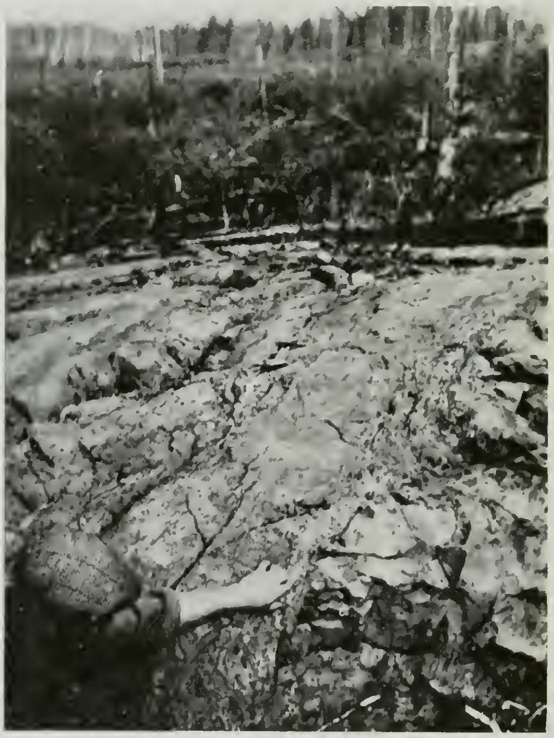
[1] Ont. Bur. Mines Report, Vol. 28, Part II, p. 15, C. W. Knight.

The volcanic fragmental tops of the flows seem to have had a dual origin. Primarily they are autoclastic rocks formed by the inclusion of the partly solidified and broken-up crust of the magma in the still liquid magma below the crust, the whole then solidifying. Secondly, doubtless a goodly percentage of it is pyroclastic and has its origin in material thrown out during the effusion by the explosive action due to the release of vapors, principally water. No bedding was noticed in the various zones of this variety of fragmental materials.

An incipient pillow lava structure was almost invariably seen in the fragmental surface.

The contacts between the surface and the basaltic bottom of the succeeding flow were continuous and well defined.



View showing sharp dividing line between two lava flows in Cook township. The hand rests on fragmental top, and the finger points to exact line of contact.

The upper zones of all these flows bore the ear marks of effusive volcanic igneous rocks in that they had a marked development of the amygdaloidal, vesicular, scoriaceous, fragmental, spherulitic and ropy structures. Lithophysæ, whose origin according to Pirrson[1] is ascribed to repeated shells of crystallization and a subsequent expansion of the cavities through the influence of the aqueous vapor liberated at high temperatures, were also noted in several instances.

Chalcedony-like inclusions occurred in several of the clastic tops. These appear to be epigenetic, i.e., formed subsequent to the solidification of the rock. The mineral shows concentric structure and frequently forms a geode. This chalcedony-like material was probably formed in a similar manner to the precious opal which fills seams and cavities in certain igneous rocks, more particularly, trachytes. The opal, it is thought, was formed by the action of hot magmatic waters upon the silicates. the silica liberated, being deposited in the hydrous form.

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[1] Pirrson—Rock and Rock Minerals, p. 265.

Pillow Lava

The pillow lava structure was well developed in nearly all the flows. Generally if forms near the top of the flow although in several places it was observed near, or at the bottom, as is the case in Flow No. 6.

A close observation for corroboratory evidence of the criterion that "the flattening of the ellipsoids of the pillow lavas on their under side due to gravity can also be used to ascertain not only the attitude of the volcanics, but the upper and lower side of the flows" referred to by M. E. Wilson[1], was made. In no one instance could this be verified. It was found that an approximately even division existed between the number of flattened and rounded pillows, and there were as many pillows with the upward surface flattened, as with the lower.

A peculiar structure was observed in the pillows of flows Nos. 6 and 13. Concentric layers of basalt are interbanded with layers of spherulites which weather white. A thin section from the spherulitic band was made and it appears under the microscope as an aggregate of round figures built up of fibres radiating from a common centre. These fibres appear to vary in composition slightly at uniform distances from the common centre giving the spherulites the appearance of having been built up of successive concentric shells. Individual spherulites under polarized light show a dark figure resembling a maltese cross. The figure remained constant when the section was rotated.

A thin section of spherulites from Corriegillis, Island of Arran, Scotland, which from the description given, the writer takes to be much the same, has been described as follows[2]. "Part of the fibrous radiating structure becomes altered to a pale green substance which under the revolution of a single nicol changes from lighter to darker hues of greens, and under fully polarized light gives greys and steel blues of the first order which point to chlorite."

From a microscopic examination the writer does not care to hazard giving the composition of these spherulites, but Dana[3] states that spherulites in the volcanic rocks of Obsidian Cliff, Yellowstone Park, are believed to consist essentially of orthoclase needles with quartz.

Spherulites are indicative of sudden cooling and rapid crystallization and their presence may give additional evidence of the now generally accepted subaqueous origin of pillow lavas.[4]

Volcanic Tuff

The greenish colored, banded, rock which formed a bed on the surface of flow No. 8 is taken to be a silicified tuff. Examined under the microscope in a thin section its fragmental nature is easily discernible. The tuff is comprised of angular pieces, principally feldspar and quartz with fragments of other minerals or rocks. The rock weathers white. Other bands of this volcanic tuff were observed but in no one instance were they over two feet wide. In one case the tuff was observed to lie between the pillow lava and the ropy fragmental top. The tuffs appear to be made up of thin laminæ which on weathered surfaces show bedding and cross bedding lines. In connection with the presence of this silicified tuff in flow No. 8 it is interesting to note that this flow has a grey lava composition to a depth of 150 feet below the fragmental surface. It is therefore thought that the formation of the tuff in this instance was due to the high silica content of the grey lava, for lavas of this type are very viscous at temperatures which would render basic magmas relatively fluid[1]. The vapors, principally water, which have been contained in the magma under pressure prior to extrusion, escape with explosive violence while in basic magmas they pass off with facility. Consequently in the case of magmas of acid composition we might expect as is the case in this instance the formation of fine fragmental material.

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[1] Memoir No. 39, Geological Survey of Canada, pp. 51 and 58.

[2] 20th century Atlas Microscopical Petrography, Part 5, p. 33.

[3] Dana, Textbook of Mineralogy, p. 372.

[4] Geikie, Ancient Volcanoes of Great Britain, p. 184. Daly, American Geology, Vol. 32, p. 78, 1902. Wilson, Canadian Geological Survey, Mem. 39, p. 54.

Porphyritic Lavas

The porphyritic lavas, probably andesite porphyrites, referred to in the various flows, have been termed "leopard rock" on account of their spotted appearance. The white weathering phenocrysts or "globs" are sometimes one inch in diameter and show up in marked contrast against the darker colored, fine grained, ground mass. Some of the "globs" show evidence of crystal form but for the most part they are irregular in outline and may possibly, in part, represent a differentiation product rather than true phenocrysts. Under the microscope they show much fracturing due to dynamic metamorphism, and evidently were originally a plagioclase feldspar but are now so altered that only faint suggestion of the original polysynthetic twinning is revealed by the microscope. Concentration of the phenocrysts or "globs" is, as might be expected, greater near the centre of the porphyritic belt and lessens as the border is approached, decreasing in concentration until only sparsely scattered throughout the flanking basalt which shows, in some cases, an amygdaloidal structure. This fact identifies the porphyritic rock as part of the flow rather than an intrusive dike paralleling the strike of the flows.

A rock analysis of a sample taken from the porphyritic belt was made and the results are given below together with two other analyses for comparison. The high percentage composition of Al_2O_3 and CaO would point to the feldspar being the plagioclase variety, anorthite.

	SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	H_2O	CO_2	XyO	Total
A.	40.30	28.94	4.70	1.53	16.2	1.23	0.92	2.71	2.99	0.64	....	100.16
B.	45.78	30.39	1.33	1.22	16.66	2.14	0.10	1.66	0.51	....	......	99.79
C.	46.24	29.85	1.30	2.12	16.24	2.41	0.18	1.98	....	....	1.03	101.35

A.—"Leopard rock" from the porphyritic belt, Cook township Lava Flows.
B.—Anorthosite, Monhegan island, Maine, U.S.A., U.S.G.S. Bull 695, page 457.
C.—Anorthosite, mouth of Seine river, Rainy Lake, Ont.—Reis & Watson, Engineering Geology, page 80.

Alteration

The principal alteration products are epidote and chlorite. The alteration of the lime, iron and alumina silicates to epidote has in places been quite general: sometimes so extensively as to form masses which consist almost entirely of this mineral.

No mineral of the zeolite group was identified although a keen lookout was kept for these minerals which so frequently occur as secondary minerals in lavas, particularly basaltic ones lining cavities and coating jointing planes or composing the filling of the amygdules. Minerals of the zeolite group are quite common in the lava flows on Keweenaw Point, Michigan, U.S.A.

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[1] Engineering Geology, Ries and Watson, p. 92.

Timiskaming Series?

East of Nettie lake, in Morrissette township, is a small area of clastic rocks and schistose derivatives. The writer has tentatively classed these rocks with the Timiskaming series owing to their similarity to certain rocks of the Kirkland area classified as Timiskaming, and the fact that they are intruded by a granite porphyry of the Algoman series. On the Martin claim, No. 8501, about 30 chains east of Nettie lake, is an outcrop of one of the upper horizons of these sediments which is a hard conglomerate comprised of water worn pebbles of greenstone, banded chert, an occasional granite and fragments of a bright red jasper, all of which readily separate from the matrix. The photograph, page 61, shows a specimen taken from this locality. The outcrop is poorly exposed and the structural relationship could not be ascertained. The lower horizons which outcrop on the east shore of Nettie lake and extend inland for 20 to 30 chains, are so impregnated with carbonate and schisted to such a degree that scarcely anything save the original clastic nature is discernible. Red jasper pebbles were seen in this rusty carbonate schist. At a point about 30 chains north along the east shore a faint suggestion of bedding was observed. The strike of the schistosity is N. 40° E., which is similar to that of like series noted in other areas[1]. A bright green talcose like mineral is abundant in the conglomerate of the upper horizon. This mineral was identified by W. K. McNeill, Provincial Assayer, as fuchsite.

Near the southern limit of Martin claim, No. 8501, a test pit has been sunk and considerable trenching done in the proximity of the contact of the granite porphyry and the rusty carbonate schist, classed as Timiskaming series. The border facies of the porphyry is a light green colored felsite mineralized with pyrite. Cracks in this felsite are filled with carbonate and are rusty. The mineral fuchsite was present in the felsite near the contact with the rusty carbonate schist.

A sample of the carbonated schisted clastic, similar to the rock comprising the outcrop at the water's edge along the eastern shore of Nettie lake, taken from an outcrop on Martin claim No. 8311, south east of Nettie lake, gave the following result on analysis:

Silica..........	56.20	per cent.	Magnesia.......	2.32	per cent.
Alumina........	14.19	"	Potash.....M..	2.84	"
Ferrous oxide...	2.27	"	Soda...........	2.33	"
Ferric odixe.....	1.54	"	Carbon dioxide.	7.10	"
Sulphide of iron (pyrite)......	4.05	"	Water (combined).......	2.34	"
Lime...........	5.08	"			
			Total....	100.26	per cent.

The Nettie lake fragmental rocks comprise the only occurrence of the Timiskaming series in the region.

Pre-Algoman Intrusives

In many localities the Keewatin series has been intruded by dikes and boss-like masses of diabase and lamprophyre dikes. The relationship of these to the Timiskaming series is unknown. Typical of these diabase intrusives is the one on the property of the Bourkes mine, forming the wall rock of the main ore body; and the diabase intrusion at the falls a few chains southeast of the office building. The diabase dike on the road allowance between the north half of lots eight and nine in the second concession, Benoit township, is also of this type.

Dikes of lamprophyre are common in the Keewatin. The dikes are usually quite narrow, the majority seen being under two feet in width. A schistose structure is frequently developed. A mica-lamprophyre dike 20 feet wide may be seen along the western boundary of Benoit township about 18 chains north of the southwest corner of the township. On the Mosher claim, No. 5834, Bernhardt township, a 12-inch mica-lamprophyre dike cuts the contorted schistose greenstone, striking N. 15° W. magnetic. This dike has been so impregnated with carbonate solution that it is altered largely to ankerite.

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[1] Geological Notes. Map No. 23a. (Kirkland Lake and Swastika Gold Areas), Ont. Bur. Mines, Vol. 23, Part II.

In several localities[1] contemporaneous with the lamprophyre dikes, are the complementary types. There is, for instance, a hornblende-lamprophyre dike 50 feet wide on the southern boundary of Melba township about one and three-quarter miles east of the southwest corner. and here an aplite dike striking north 2° west magnetic cuts in between the lamprophyre and the basalt. Other instances of complementary dikes will be cited later.

Algoman

The granite, syenite, grano-diorite (monzonite) batholiths and bosses, also the feldspar-porphyry and the quartz-porphyry dikes occurring throughout the area are thought to belong to the Algoman series. There is a possibility that minor occurrences mapped as Algoman on the accompanying map may be acid phases of the Nipissing diabase.

As has already been pointed out, the Timiskaming (?) series in the vicinity of Nettie lake was observed to have been intruded by a granite porphyry. This porphyry is typical of the area, variations being largely resultant from conditions of intrusion and solidification. Analysis of the granite-porphyry showed a silica content of 72.86 per cent. The eastern extension of the Winnie lake-Maisonville township batholith of hornblende-granite occupies the southwest quarter of Bernhardt township. This batholith varies quite locally from a hornblende-granite to a pink syenite or to a quartz-diorite. The two latter seem to be border facies of the granite, for this occurrence was particularly noted near the border of the batholith. The granite passes gradually into a syenite or grano-diorite without material change in texture, and this is indicative of some process of differentiation subsequent to the entry of a single body of the parent magma into its chamber rather than successive intrusions of different magmas. This feature was notably observed on the high ridge southwest of Bourzk lake. The pink syenite passes gradually to a granodiorite in which the hornblende predominates, and in which pink feldspar (orthoclase) and quartz comprise as low as 25 per cent. of the rock. A similar transition was seen northwest of Webash lake. The granite and syenite are always of a deep rose color.

The only other noticeable occurrences of granite are near Butler lake along the Benoit-Black boundary in the southwest corner of Black township. and in Thackeray township south of No. 3 post of claim No. T.T. 7. The first two occurrences have biotite and other femic minerals whereas that last noted is a binary granite.

In the monzonite, or grano-diorite, referred to on the accompanying map No. 30 c, the femic minerals predominate but quartz, pink orthoclase, and some plagioclase feldspar are plainly visible. Thin sections of this type of rock from three different localities under the microscope showed a wonderful development of a micropegmatitic texture, being an intergrowth of quartz and feldspar, one mineral containing particles of the other. The arrangements present a more or less regular pattern which, from its fancied resemblance to certain ancient inscriptions, has been also termed "graphic texture."

Many dikes of red and grey feldspar-porphyry cutting the Keewatin were seen. Under the microscope the rock shows phenocrysts of acid plagioclase, and occasional quartz and hornblende, imbedded in a fine grained groundmass consisting of feldspar, quartz and other minerals.

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[1] See page 46.

A rather singular porphyry may be seen on James claim, No. 8201, in Morrissette township. The porphyry contains pink phenocrysts three quarters of an inch in diameter of orthoclase feldspar displaying a distinct zonal structure, and smaller (not greater than one quarter of an inch) phenocrysts of plagioclase feldspar with an occasional quartz, imbedded in a grey groundmass. The dike is 30 feet wide and strikes approximately northeast and southwest. The porphyry weathers a faint pink color. Many of the porphyry dikes seen in Bernhardt and Benoit townships have a general east and west strike. On Bergstrand claim, No. 6850, Benoit township, there are several dikes of feldspar-porphyry ranging in width from four to thirty feet, all of which have an east and west strike. These dikes closely resemble those in the southwest corner of Bernhardt township in that they have considerable hornblende and some larger blood-red feldspar phenocrysts.

The occurrence of quartz-porphyries is particularly confined to the Goodfish lake area and the vicinity of Jack Post camp, a few chains north of the third mile post on the southern boundary of Morrissette township. This porphyry has already been fully described by A. G. Burrows and P. E. Hopkins[1].

Cobalt Series

The Cobalt series represents the latest sediments of the area overlying the older complex. The series consist of conglomerate, greywacké, argillite, arkose and quartzite. Individual members of the series are not abruptly defined. In a general way there is an orderly succession from a basal conglomerate through slate-like greywacké and argillite to greywacké, or more rarely in this area to an impure quartzite or an arkose which in turn is overlain by an uupper conglomerate. The bedding planes, in all the outcrops seen, are horizontal or nearly so. The beds appear undisturbed.

The occurrence of the Cobalt series in the Black River area is confined to the townships of Black, Benoit and Lee.

In Benoit a hill 100 feet high in lot two in the first concession comprises the largest area. Small outcrops extend northward to the fifth concession; all outcrops are west of the lot ten and eleven line.

In Black township the distribution is more widespread, outcrops being seen in almost every section of the township. The 150-foot hill in this township west of Butler lake is a landmark for miles around. Here the lowest horizon is a conglomerate, largely composed of red granite boulders imbedded in a greywacké matrix. The uppermost horizon is a red greywacké, extremely resistant to weathering. The intermediate beds of argillite and slate-like greywacké being less resistant, have been more disintegrated forming a talus which spreads for several chains around the cliff's base on the north and west. The weathering of these intermediate beds leaves the upper ones overhanging, giving the hill a top-heavy appearance.

An outstanding feature of the larger outcrops is the precipitous faces. In Black township, for example, there are several east to west ridges and all have precipitous faces toward the north. Possibly these steep faces are due to faults.

As the individual members of this series have already been fully described [2], a repetition will not be made here.

The relationship of the Cobalt series to the underlying basement was only seen at a few points. In the southwest quarter of the south half of lot eleven in the second concession of Benoit township, a conglomerate underlying a bed of slate-like greywacké lies unconformably upon the eroded surface of Keewatin greenstone. The outcrop of conglomerate is only exposed by trenching for a few square yards.

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[1] Ont. Bur. of Mines, Vol. 25, 1916, Part I., p. 260.

[2] W. G. Miller, Ont. Bur. of Mines, Vol. 19, Part II, 4th edition, 1913.
M. E. Wilson, Canadian Geological Survey, Mem. 39.

In Black township at a point two and a quarter miles north of Woollings' camp an east to west ridge of conglomerate has a sheer drop on the north side of 20 feet. About 100 feet north there is a low outcrop of basalt, mineralized with pyrite, which appears to directly underly unconformably, the conglomerate although the actual point of contact was obscured.

A glacial erratic of conglomerate 20 to 25 feet in diameter was observed just north of Woollings' camp and Scotties Springs road and about 20 chains east of the camp. Numerous other erratics are scattered throughout Black township.

Keweenawan Diabase

The youngest rocks of the pre-Cambrian in the Black River area are dikes and small intrusive masses of diabase, trap and gabbro. They may correspond in age to the Nipissing diabase, or the later olivine diabase dikes. They vary in texture from aphanitic to coarse in grain. A microscopic examination of them shows that they are augite-diabase irrespective of the texture. They show a texture which is identical with that of other well known Keweenawan rocks of Northern Ontario, i.e., a beautiful ophitic texture, the lath-like crystals of basic plagioclase cutting into and penetrating the crystals of augite. The percentage composition (megascopically examined) of the femic minerals varies and from the one outcrop specimens differing greatly in appearance may be obtained. The color and texture are variable according to solidification conditions. Small dikes and marginal masses are black, elsewhere the general color is greyish green to dark green and the texture medium. In some only a very minor amount of pyroxene is present. There are two types of diabase, one with olivine, the other olivine free the latter being by far the more common type.

The relationship with the older underlying rocks, other than the Keewatin, was seen only in a few instances. These will be cited later.

As much of the diabase mapped has been correlated only on petrographic evidence, it is possible that some may represent older intrusives. In this connection it is noted that P. E. Hopkins[1] states that in the area to the north there are diabases which microscopically are identical with the Nipissing diabase at Cobalt, but which appear older than the latter.

In both Bisley and Black townships, narrow complementry dikes were seen cutting the diabase. About 3 miles north of Woollings' camp, in Black township, there is an outcrop several chains in diameter of this fresh diabase. At the southern limit of the outcrop the diabase can be seen to intrude and overlie the Cobalt series. The visible member of the Cobalt series was an argillite. Complementary dikes occurred also at this point.

On the Bergstrand claim, No. 6850, being the southeast quarter of lot eleven in the fourth concession of Benoit township, one of the feldspar-porphyry dikes, already referred to in connection with the Algoman series, is paralleled on the south by a dike two feet wide of fresh diabase. The texture of the diabase is aphanitic at the contact, gradually becoming coarser until a fairly coarse texture is assumed. The diabase does not actually cut the Algoman porphyry; the gradation of texture, however, would point to the porphyry having been in place prior to the intrusion of the diabase. A similar relationship was also noted in the north half of lot eleven in the third concession of Benoit township.

In no one instance were the exomorphic effects of the diabase important. The intruded rock was apparently unaltered three or four inches from the contact.

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[1] Marginal geological notes, Map No. 24a, Beatty-Munro Gold Area.

Glacial and Recent

It is roughly considered that at least 75 per cent. of the Black River area is overlaid with a mantel of boulders, gravel, sand and boulder clay. The clay, sand and gravel is frequently stratified or rudely so.

Much of the clay area of Benoit township is already settled and doubtless in time other level tracts of clayey soil throughout the area will be cleared for agricultural purposes.

No attempt was made to differentiate the areas of clay, sand or gravel, and a geological history of the glacial period does not fall within the scope of this work.

Economic Geology

The Black River area comprises 325 square miles of the great pre-Cambrian region, which in Ontario has produced such important mining centres as Porcupine, Kirkland Lake, Cobalt and Sudbury.

There is but one property in the area upon which a mining plant has been installed, and few localities where anything more than the most superficial prospecting has been done. Therefore, the fact that the area has not a producing mine, has little or no bearing on its future possibilities; but the fact that the formations are akin to those of neighbouring camps already proven, combined with the fact that there exists a widespread distribution of Algoman granite, syenite and porphyry intrusives, with which the deposition of gold is said to be associated, augurs well for the future of the area.

In proximity to these acid intrusives gold should be carefully prospected for, particularly where the greenstones have been rendered schistose. In these localities, as has already been pointed out[1], prospectors should be on the look-out for tin.

Veins are comparatively plentiful in the area and in some localities they appear well mineralized. The principal types being:—

(1) Fissure veins containing chiefly calcite, and minor quantities of quartz as gangue, with sphalerite, galena and other sulphides in subordinate amounts. These deposits are rarely auriferous in economic amounts.

(2) Quartz veins occupying fissures. These frequently contain pyrite, in crystals, and are often auriferous.

(3) Torsion cracks, which have been subsequently filled by solutions depositing quartz, comprise another class. These usually take the form of short lenticular splashes of quartz which, unless very numerous, could not constitute an ore body even though mineralized.

(4) Joint planes which have been filled with quartz. This type is almost invariably narrow and frequently carries free gold. The horizontal veins, occuring in the vicinity of Bourkes, have been classed with this type.

(5) Sheer zones have been infiltrated with quartz and calcite. The quartz and calcite lenses vary from a fraction of an inch to several inches, or a foot in width. The rock infiltrated by the quartz and calcite bearing solutions is usually impregnated with iron pyrites. The main vein of the Bourkes Mines Limited, is considered as one of this class.

(6) Pyrrhotite and sulphide bodies occupying channels similar to the foregoing. The sulphide bodies are believed to have the same origin as the auriferous quartz deposits, that is to say, to be genetically connected with the Algoman intrusives[2]. Granite or porphyry intrusions were observed in close proximity to these deposits, and in the deposit on the Post claim—No. L.L. 4868, Morrissette township

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[1] Cyril W. Knight, Marginal geological notes, Ben Nevis Gold Area, Map No. 29c.

[2] Miller and Knight, Metallogenetic Epochs in the Pre-Cambrian of Ontario, Trans. Royal Society, 1915, Vol. 9.

—the deposit on the footwall had a felsitic border facies 5 feet wide. The sulphide ores in northern Manitoba are believed to have had a similar origin.[1]

(7) Parallel slip planes coated with quartz and a thin film of molybdenite[2] as in the Goodfish Lake area.

Veins of the fissures and sheer zone types frequently contain brecciations of the wall rock, the edges of which have either been altered to secondary minerals or partially replaced by sulphides. Secondary minerals such as chlorite and epidote are common.

No general strike is common to the veins in the area; there is, however, more fissuring in an east and west direction, and at right angles thereto, than in any other. The channels, through which the vein-forming solutions passed, appear to have had a dual origin. From the close association of some of the gold-bearing veins (1) with the pre-Algoman diabases it is inferred that some of the fracturing, directly or indirectly, was caused by these intrusives. Again, numerous veins cut or parallel the Algoman intrusives and the fracturing forming this class may be attributed to these intrusives, which would mean that these deposits were formed immediately following the acid intrusions. The close connection between the gold quartz veins and the Algoman intrusives is shown by the occurrence of blotches or stringers, in practically all the veins, of a deep pink, feldspathic mineral, identified mainly as orthoclase feldspar. This is considered to be a seepage from the granite intrusives. Some of the narrow granite-porphyry dikes are reported to carry small gold values.

Notably:—

1.—Main vein on Bourkes Mines Ltd. property.
2.—Auriferous veins on Webb claims, lot 7, con. I and II, Benoit township.
3.—Auriferous veins on Skjonsbye claim, lot 2, con. I, Benoit.

Gold occurs chiefly in the native state in narrow veins in a quartz-calcite gangue. Tellurides of gold are reported in several localities and have been identified[3] in the main vein on the Bourkes Mines Limited property. This latter occurrence—as the telluride—while unique has not to date proved to be of economic importance in Ontario. Gold is frequently associated with the minerals molybdenite and pyrite.

The cessation of work by the Bourkes Mines, Limited, has been a great setback to the further development of prospects in the vicinity of Bourkes; and while gold has been found on many properties, capital is lacking to prove or disprove their economic value.

To sum up, the greater part of the area has been but slightly prospected. Gold has already been found in many localities and the economic importance of these discoveries is still problematical. The vicinity of acid intrusions should be carefully prospected for gold and tin. The latter mineral may occur in quartz veins on the borders of granite knobs and in granite, or as grains disseminated through the rock adjacent to the granite. Quartz, topaz, tourmaline and fluorite are commonly found with tin deposits, as are also wolframite and scheelite, and other contact minerals.

The galena-sphalerite deposits should be carefully examined for silver and gold, which if present in sufficient amounts, would make these deposits workable. These deposits do not, however, appear to carry more than traces of gold, whereas silver values up to 57 ounces per ton have been obtained.

Description of Black River Area according to Townships

A more detailed account of the topography and economic possibilities of the nine townships of the Black River area is given in the following paragraphs, together with brief notes on some of the mining claims.

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[1] E. L. Bruce, Mem. 105, Can. Geol. Sur. 1908, p. 61.

[2] Ont. Bur. Mines, Vol. 25, Part 1, 1916, p. 262.

[3] Ont. Bur. Mines Report, Vol. 26, p. 250.

Cook

Cook township consists largely of low country covered with an exceptionally fine growth of black spruce. Considerable wood for both pulp and lumber purposes has already been cut and timbering operations are still active. Practically none of the township is under cultivation. Only one settler's clearing was seen.

There are three important hills all comprised of Keewatin rocks, two along the boundary in the southwest corner, and one named Lava Flow mountain in the northwest part of the township.

The predominant rocks are Keewatin which in many localities are well exposed. The rocks are generally massive, and little fissuring was observed. Shear zones wherever seen had an east and west strike. Few veins were seen, and no extensive mineralization noted.

The Pike river and the creek which flows along the north portion of the third concession are not at present navigable owing to numerous log jams.

Barnet

Barnet township is west of Thackeray, and, like its neighbour, is not easily accessible. The shortest route is by the western boundary of Melba from where the Black river flows a few chains west of the line. This route was followed by our party, but the line especially along the western boundary of Barnet is poorly cut out, extremely difficult to follow, and not practicable for packing. It is therefore recommended that from the southwest corner of the township some alternative route be chosen to enter the township. The majority of the lot and concession lines are well cut out and offer good travel routes, particularly the line between the third and fourth concessions, which has been used as a trail.

It has been estimated that 15 per cent. of the township is rock and a like amount muskeg. There are few outstanding hills or ridges, the principal one being in lots one in the third and fourth concessions, and at the south of Fitter lake. From the last named point a splendid view of the township may be had. The balance of the township is characterized by the evenness of its landscape and the numerous creeks.

Patches of spruce and poplar suitable for pulp wood purposes are frequently met with. In the north of the township areas of sandy country exist, many of which have been burnt over. There are areas of clayey soil, well drained and suitable for agricultural purposes.

The Pike river is a good stream 50 to 60 feet wide, four to six feet deep with high banks, and a fair current. This stream, were it not for the numerous log jams, would be quite navigable, so far as we could judge from various views obtained during our exploration work, and if so it should be cleared out in order to give freer access, not only to Barnet, but to the northern part of Cook township as well.

The dominant rocks, are the same monotonous types of Keewatin Lavas so characteristic of this and adjoining areas. In small areas there are dikes and boss-like masses of granite, grano-diorite and porphyry. In no instance had the vicinity of these intrusives been exploited.

Thackeray

Thackeray township is accessible by a trail which follows the eastern boundary of Melba township northward from the crossing of the Black river. This trail was well travelled when the first stakings were made in the township and is still in good condition.

The general character of the whole township is that of a gently undulating tract of land. The north and northwest parts are largely jackpine, sand plain country. The rock outcroppings are not prominent, being confined to the southwest quarter of the township.

The prevailing rocks belong to the Keewatin series and the only outstanding geological feature is the many intrusive dikes of feldspar porphyry, and granite: a few of these have been shown on the accompanying map. A very beautiful syenite-porphyry containing rectangular, elongated phenocrysts of feldspar sometimes three quarters of an inch long and only one sixteenth to one eighth of an inch wide was seen *in situ,* in several places. This porphyry was noticed only in Thackeray township. The mineralized veins seem to be closely associated with the acid intrusions of porphyry or granite. Assays of gold were obtained but the writer is informed these were not high. The prospecting in Thackeray township appears to have been of an extremely superficial type which accompanies a "rush," and in reality does more harm than good to an area. From the numerous small dikes of the Algoman series and the amount of mineralization seen in places it would seem that this area should be more carefully prospected.

Grab samples from a test pit along the trail running north of the Howey camp site, and from workings thought to be on Andrews claim [1] did not give any gold values.

No free gold was seen on any of the claims although finds have been reported in this locality.

Base of "Defiance Peak," Black township. Note the almost horizontal strata of the Cobalt series.

Black

Black township is accessible either by the Woollings' camp road from Scotties Springs, or by the water route from Bourkes already mentioned.

The topography consists mainly of rolling well drained country with unimportant hills. The north of the township is more rugged. From the prominent peak of the hill west of Butler lake a commanding view of the township may be had. Large sand plain areas exist. The road from the eastern boundary to the creek crossing, south of Errett lake, passes through jack pine sand plain country. There are numerous prominent sand ridges in the northwest section of the township.

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[1] The writing on the claim posts is no longer legible and the claim lines are so irregular and difficult to follow that the writer was not positive of the claim. The discovery consisted of a highly inclined quartz vein containing inclusions of the 5-20 inch felsite dike which formed the footwall and of the Keewatin diabase which comprised the hanging wall. The quartz, the felsite dike and the hanging wall rock were well mineralized with sulphides.

The entire township is well timbered and there are many excellent patches of black spruce and of poplar. T. S. Woollings and Co,. of Englehart, hold a timber permit for Black and Lee townships. Pulp wood cutting operations were commenced in the spring of 1920. Camps have been constructed in various parts of the township and by the fall of 1920 several thousand cords of pulp wood awaited shipment over the company's railroad to which steel is being laid from mileage 181 on the Temiskaming and Northern Ontario railroad westward into Black township.

Defiance peak, Black township, comprised of slate-like greywaké and conglomerate.

Geologically the outstanding feature of the township is the numerous remnants of the Cobalt series. In Black township as in the balance of the area the dominant rock types are Keewatin. Considerable fissuring, schistosity and mineralization was noted, particularly in the northeast part of the township. In this section there are some old stakings upon which much trenching has been done and a few test pits sunk. About one half mile west of Defiance peak there are some old workings, 30 to 40 feet deep, judging from the dump, on a highly mineralized calcite vein containing numerous fragments of the basaltic wall rock. The vein shows a banded structure of calcite and some basic material now largely altered to chlorite, heavily mineralized with sulphides. Sphalerite is the most abundant mineral—then iron pyrites, galena and chalcopyrite in decreasing amounts as named. A grab sample failed to show any gold values. In the vicinity much mineralization was seen and it was thought that this section merited more intensive prospecting. Small areas of Algoman granite are exposed in the northeast and southwest of the township.

The only work in progress during the summer of 1920 was on claims along the trail west of Malloch lake. Here some blasting has been done on a vein complex in the Keewatin dolerite consisting of numerous lenticular shaped veinlets of quartz, slightly mineralized with pyrites. A 12-foot test pit has been sunk on a mineralized chlorite schist sheer zone, the strike of the schistosity being south 50 degrees east magnetic and dip almost vertical. The joint planes and planes of schistosity have been infiltrated with calcium carbonate. Values in gold are reported from this locality.

Benoit

The Temiskaming and Northern Ontario Railway runs through the centre of Benoit township, making all parts readily accessible; in addition road allowances have been cut and well used trails are numerous.

At present the only post office in the Black River area is situated at Bourkes, although it is understood that an application has been made for the organization of another in the north of the township on the railroad, about one half mile south of Scotties Springs, where a thriving settlement has recently been established. Black River is the proposed name of the new post office.[1]

A settler's home and clearing along the Black river, in Benoit township.

Many quarter sections have been taken up as homesteads, much of the land is cleared and some is under cultivation. During the summer of 1920 there was an influx of settlers into the northern half of the township, especially along the Black river and the railroad.

The topography of the township is generally flat and the land well drained. Swampy areas are not large. The northwest quarter of the township is lagely sandy with occasional rock outcrops. A splendid growth of poplar and spruce suitable for pulp wood is scattered throughout the township and many cords have already been cut by the enterprising settlers.

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[1] During the summer of 1921, Scotties Springs P.O., was opened at Yorkston station on the T. & N. O. railway in Cook township just north of the Benoit boundary.

There are few outcrops of rock and these are neither of great extent nor elevation, but rise, as low rocky knolls of greenstone and diabase, above the comparatively level clay-covered land. The rocks of the township are nearly all basic lavas of Keewatin age, the only variations being the small areas of granite, diabase and sediments of the Cobalt series. Feldspar-porphyry dikes are numerous.

Camp buildings of Bourkes Mines, Ltd., Benoit township, looking northeast from shaft.

Head frame and boiler house, Bourkes Mines, Ltd.

Gold has been found on several properties, and in practically every instance the values were obtained from quartz veins in the greenstone. Much of the greenstone in Benoit is quite schistose.

*Bourkes Mines, Limited**.—This property comprises the south half of lot nine in the second concession of Benoit. The rock outcrops are confined to a bend in the White Clay river; the geology is shown on the accompanying rough plan of the com-

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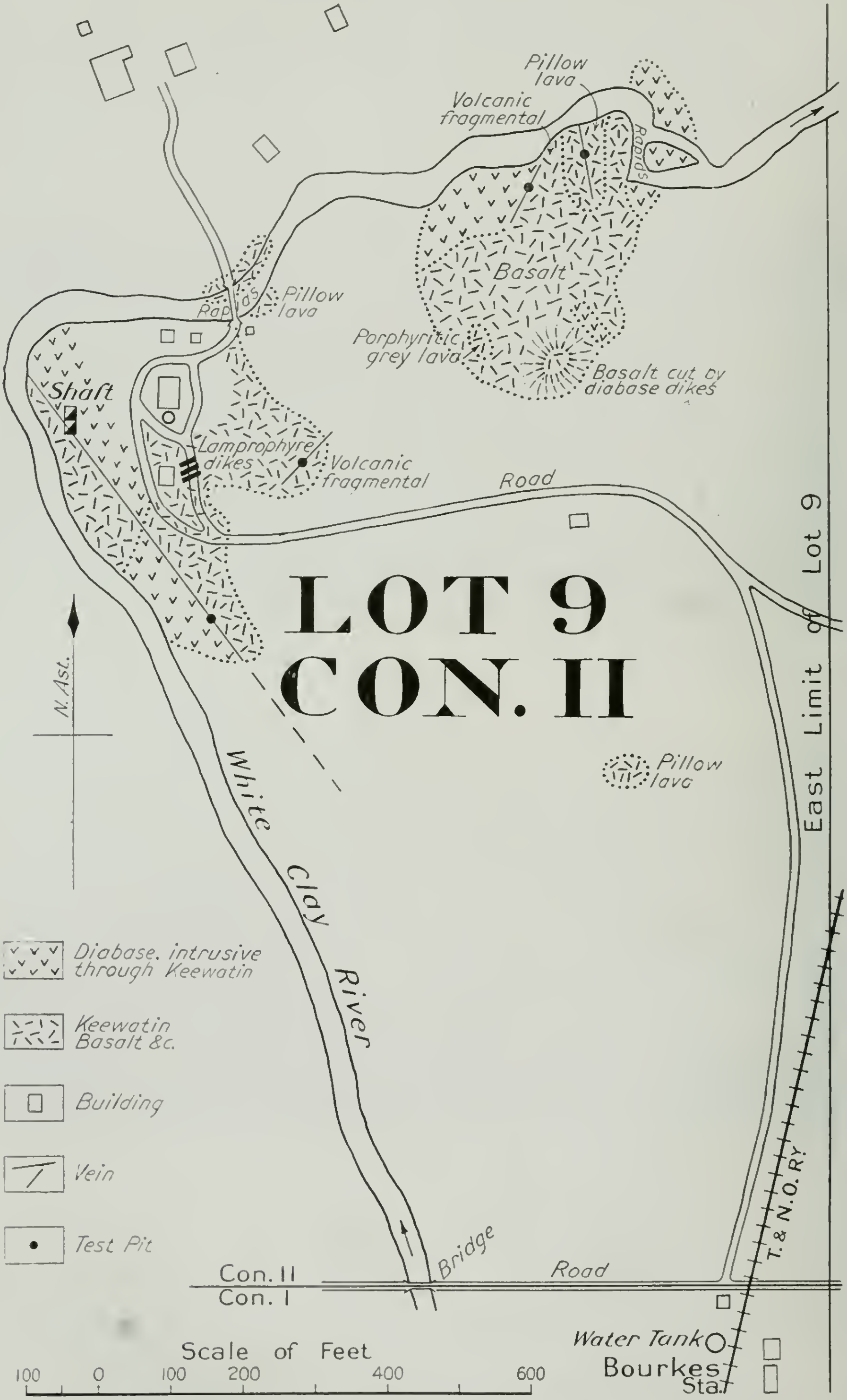
(*) Reference has already been made to this prospect by A. G. Burrows. *See* Gold Bearing Veins in Benoit Township, Ont. Bur. Mines Report, Vol. 26, 1917, pp. 248-251. The asterisk (*) where it occurs again refers to the 1917 Report.



Plan of Bourkes Mines, Limited, scale 250 feet to the inc pany's premises. The White Clay river crosses the lot. Barometric readings of the water level showed a drop of 20 feet across the property. This drop is made up of rapids and small cascade falls of from one to four feet at various points along the river, chiefly in the portion of the stream flowing east.

The company have a plant installed which is apparently in first class condition and exceptionally well housed. The camps are well built and attractively located on the rising ground north of the White Clay river away from the workings.

The surface equipment, in the main, consists of a cookhouse, a bunkhouse, a mine superintendent's residence, a mine office, an equipped assay office, an equipped blacksmith shop, a boiler house with 2-100 H.P. horizontal F.T. boilers, hoist and compressor house with a 12-drill Allis-Chalmers-Bullock compressor and Ingersoll-Rand hoist with cylinders 10 inches by 12 inches. The equipment was installed and buildings completed shortly before the mine closed down.

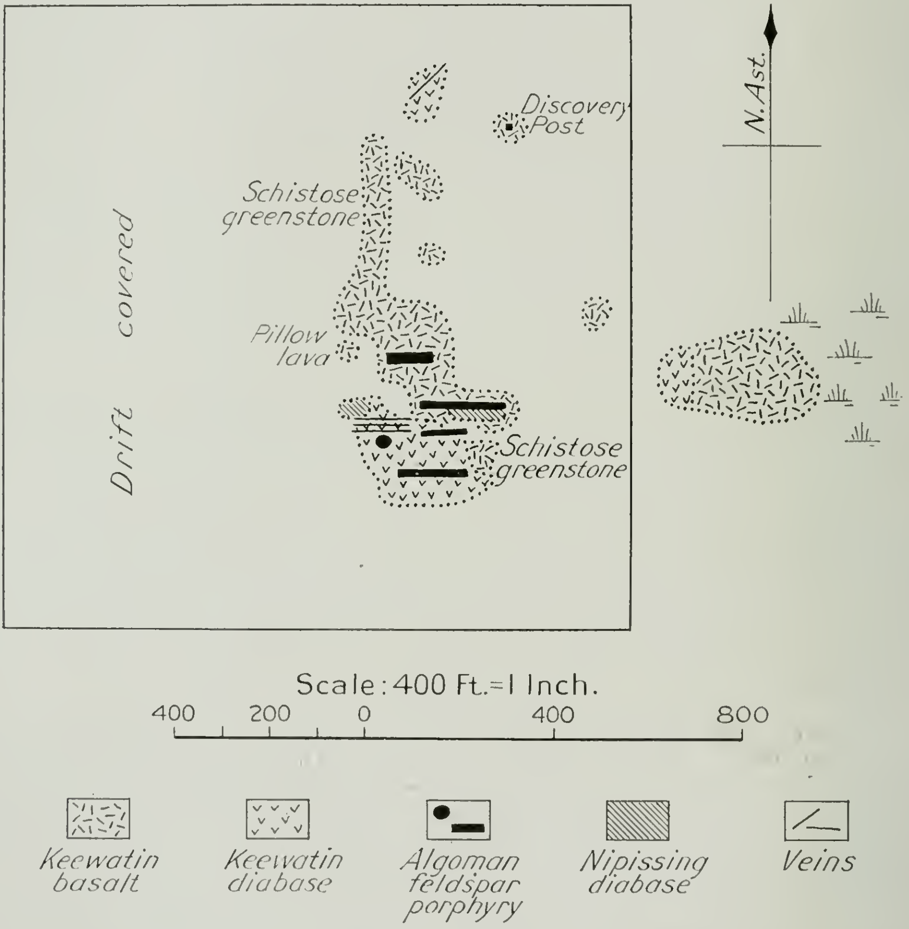
The shaft has been sunk on the main vein, which will be described later, to a depth of 400 feet and some drifting has been done at various levels. The underground workings were filled with water during the summer of 1920 thus preventing an examination of the developed ore body. Many specimens containing free gold are scattered about the dump and some of these are extremely rich in the precious metal. The gold was noted to occur in the quartz associated with calcite, the latter may have been a precipitating agent for the gold. A telluride of gold has also been identified.

The ore body consists of a shear zone striking south 28 degrees east magnetic, dip almost vertical. The rock in this zone is altered to a green contorted schist over a width of from four to eight feet. At the southern limit of the exposure a test pit has been sunk, and here the southwest wall consists of fairly fresh diabase and the northeast of basalt. At the northern limit these conditions are reversed. Into this shear zone have come the mineral bearing solutions filling the cavities and forming veins of quartz and calcite from a fraction of an inch to several inches in width. The gangue and contorted rock have been copiously impregnated with crystals of iron pyrites and lesser amounts of chalcopyrite, galena and molybdenite. Stringers of a deep pink feldspathic mineral, as well as narrow felsitic dikes, have also intruded this contorted rock. In places the wall is well marked while in others it appears to merge into the adjoining rocks.

Bunting Claims (*Johnson*) *Nos. 6639-6640.*—These claims comprise the west half of lot nine in the first concession of Benoit. On claim No. 6640 most work has been done. The greenstones, with some pillow lava structure and volcanic fragmental rocks, are cut by dolerite (diabase?) dikes. In close proximity to these intrusions are some well defined mineralized veins. Test pits have been sunk and stripping done on several of these. Near the southern boundary of this claim a shallow test pit has been sunk close to a vein junction, on a parallel quartz-vein system in a schistose zone. To a depth of three to four feet the schistose greenstone has been altered to a rusty carbonate. There is much mineralization with sulphides principally iron pyrites. The foregoing vein strikes north approximately, and immediately south of the test pit it is intersected by a quartz vein striking northeast. This latter is bordered by a narrow felsite dike.

Potter (*Wickstead-Maloof*) **No. 5381.*—An inclined shaft following the dip vein has been sunk to a depth of 40 feet. Along the footwall between the quartz vein and the pillow lava is a felsite dike heavily mineralized with sulphides. The vein outcrop is rusty and the greatest mineralization is along the footwall adjoining the felsite dike. Native gold was seen in places. The vein also contained specks of galena and some chalcopyrite. A channel sample taken across the vein and footwall dike from a point 12 feet below the surface, the shaft being full of water to this level did not give an encouraging assay for gold.

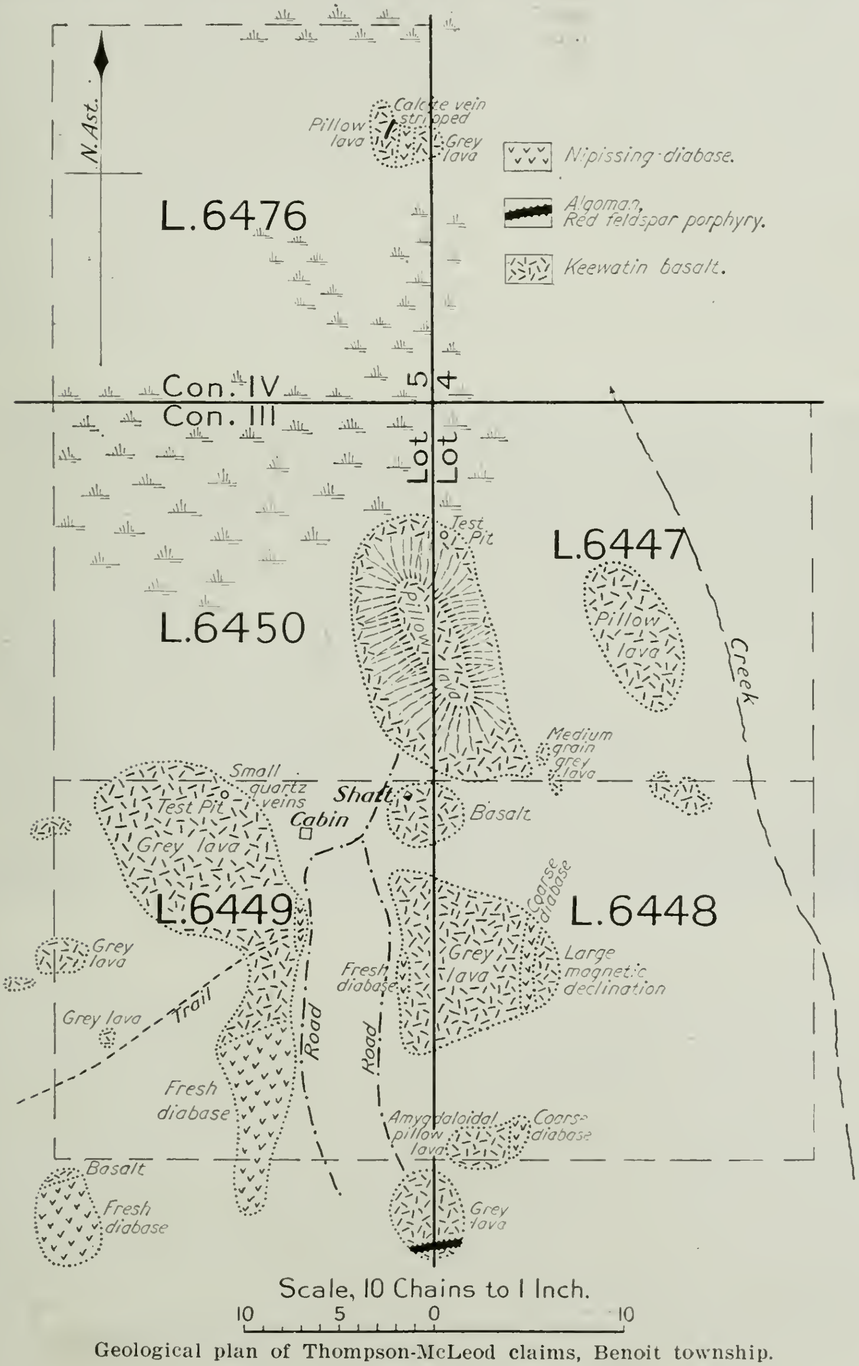
Scotvold Claims, Nos. 6184-5835.—Claim 6184 comprises the southwest quarter of the north half of lot five in the first concession of Benoit. The country rock is principally pillow lava. Some work has been done on a lamprophyre dike striking north, bordered on the west by diabase and on the east by pillow lava. The dike is mineralized with pyrite and Mr. Scotvold reports an assay of $3.00 per ton in gold. The dike continued north into Nelson claim No. 5831, and gold values are reported from the dike on this claim also.



Geological plan of Bergstrand claim, Benoit township.

Bergstrand Claim No. 6850.—This claim is located in the southeast quarter of the south half of lot eleven in the fourth concession of Benoit. A plan of the claim is given on account of the interesting geologic features. Small assays of gold have been obtained from the porphyry dikes and some of the veins. Much surface work has been done and it is the intention of the owner to sink test pits on some of the more promising finds.

Cotterill Claims Nos. 5309, 5921.—The claims comprise the north half of the south half of lot seven in the first concession of Benoit. Considerable surface work has been done and various leads have been stripped and trenched. On claim No. 5921, near the southeast corner, are two parallel veins striking north 87° east and dipping 45 degrees south. The veins are 30 feet apart. The wall rock is somewhat schistose, volcanic fragmental altered to chlorite and impregnated with iron pyrites. The principal discovery is on No. 5309 and consists of a well defined quartz vein striking south 80 degrees west. The greatest width of the vein is 6 feet and offshoots extend into the flanking altered rock. In places the main vein splits into a parallel system of veins, each a few inches wide. A test pit has been sunk to a



Geological plan of Thompson-McLeod claims, Benoit township.

depth of 15 feet. Near the bottom of the test pit, the vein which is six feet wide on the surface, divides into a series of veins cutting an altered porphyry and a basic rock impregnated with iron pyrites. Various assays of from $3.00 to $24.00 per ton in gold are reported.

Thompson-McLeod.—This group of claims is located in the north half of lots four and five in the third concession of Benoit, and the southeast quarter of the south half of lot five in the fourth concession. A plan of these claims appears in the text. The principal workings consist of an inclined shaft following the dip of a 16 inch wide vein striking south 8 degrees east and dipping about 65 degrees east, cutting a grey lava knoll. On the surface about 15 feet distant is another vein 4 inches wide with parallel dip and strike. From the west side of the knoll an adit has been driven along the strike for 60 feet. The adit connects with the main shaft about 20 feet below the surface. As the shaft was filled with ice to the level of the adit examination at depth was not possible, but the vein is reported to be several feet wide at the bottom of the shaft. The wall rock is schisted for a few feet on either side of the vein. The quartz is of milky white color, and in places it is stained with iron oxide. The wall rock and border of the vein are mineralized with pyrite. Free gold is reported to have been found in several places along the vein.

Thompson-McLeod vein and adit, Benoit township.

*Skjonsbye-Klanderland**.—These claims have already been fully reported upon, only new features therefore will receive mention. A very favourable gold assay of $21.60 per ton was obtained from a grab sample taken from the dump surrounding a 14-foot shaft which was sunk on a flat lying 8 inch quartz vein. The shaft is located near the west boundary of lot two in the first concession about 10 chains south of the northwest corner of the lot. The wall rock within a few inches of the vein is heavily mineralized with pyrite and chalcopyrite, and there is also some of the same minerals in the vein.

The large outcrop just south of No. 1 post of claim No. L. 4287 shows two highly inclined lava flows and portions of two others.[1] Leopard rock, porphyritic greenstone, forms belts in some of these flows. In other particulars also, they resemble the Cook township lava flows.

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[1] These flows were not seen by the writer but were reported by his assistant.

Webb.—This group of six claims comprises the north half of the north half of lot seven in the first concession of Benoit and the south half of lot seven in the second concession. Extensive surface work has been done and several pits sunk. Gold has been found in flat lying veins just north of the road allowance. The basalt in this vicinity is liberally impregnated with iron pyrites in crystals; some cubes one quarter of an inch in diameter were seen. A red feldspar porphyry dike striking a little west of north crosses the road allowance. The dike is well mineralized. South of the road a shaft has been sunk on the frozen basalt-porphyry contact. In October, at the time our survey party were withdrawing from the field, exploratory work on these claims was resumed under the personal supervision of the owner, G. F. Webb, of Hamilton, Ont. The shaft referred to was dewatered, a tripod horse power hoisting apparatus installed, and sinking resumed.

Melba

All parts of Melba are easily accessible from the Black river, which flows from east to west through the centre of the township.

The rock outcrops are mainly Keewatin and comprise roughly about 15 per cent. of the area. Two occurrences of pillow lava are perhaps worth noting because of their unusual features, one south of Douglas lake where single pillows were observed having a 5-foot major axis, and 2.5-foot minor axis; the other is on the southern boundary west of Kellett lake where the pillows have a porphyritic texture, their major and minor axis being 7 and 4 feet respectively.

Parts of the township are wooded with spruce and poplar suitable for pulp wood. Much of the township is swampy, but in the west half there is a goodly area of high clayey land suitable for agricultural purposes. No sand plain or sand ridge areas were seen. The few prominent hills have already received mention in the opening chapter.

Bisley

The eastern half of the township is largely low, poorly drained, spruce covered country and sand plain or ridge areas. The prevailing rocks are Keewatin and few intrusions were noted. There is one area of fresh diabase a little north of the centre of the township and in the neighbourhood of this some veins and dikes were seen. Prominent hills are confined largely to the vicinity of Lauramay lake, where several rocky hills over 100 feet high, are situated.

Bisley township appears to have been little prospected or travelled although it is accessible from the Black river.

The abnormal magnetic declination, as great as 70 degrees west on the section south from Lauramay lake to the southern township boundary, is worthy of note and investigation.

Bernhardt

The township of Bernhardt is one of the most rugged in the area, possessing many prominent ridges and hills. The height of land between the Hudson Bay and St. Lawrence drainage basins follows a general line from east to west across the centre of the township.

All parts of the township are readily accessible by canoe route from Amikougami lake. Thanks to the efficient work of the fireranger stationed in this township during the summer of 1920, practically all the trails and portages were brushed out and reblazed, making travel less difficult.

A feature of the geology of Bernhardt township is the large area in the southwest occupied by the granite batholith. Only the approximate boundary of this granitic intrusion was ascertained by sections. The balance of the outcrops in the township are basaltic in type; the only exceptions being the occasional small outcrops of fresh (Nipissing?) diabase along the northern boundary and west of Lancaster lake and an occasional feldspar-porphyry dike. The southern part of the township has been the most prospected, resulting in gold discoveries on several claims. The township as a whole, however, does not appear to have been extensively prospected.

During the summer a few prospectors were engaged on assessment work on their claims and whenever possible these were examined. A few brief descriptions will be given here.

Ayoub Claim, L6075.—This prospect is located on the west shore of the northwest arm of Amikougami lake. The country rock consists of amygdaloidal basalt and pillow lava. At the lake side considerable stripping and blasting away of rock has been done on a quartz vein having some free gold showings. The vein continues into Bourzk claim No. 8242, to the north.

Bourzk Claim, 6354.—This claim is situated at the north end of the northwest arm of Amikougami lake. Considerable trenching, stripping and some blasting has been done on a vein complex in the pillow lava, 20 feet wide striking about north astronomic. The complex consists of a banded light grey to green felsite interbanded with quartz and calcite. In places the calcite bands are 15 inches wide. Minute stringers of a red feldspathic-looking material were also observed. Brecciations of the wallrock and of the felsite were included in the calcite. There was a scant mineralization with pyrite. Mr. Bourzk reports an assay of $5.40 in gold per ton from this vein.

Solomon Claim, 6429.—The claim is located on the west side of the northwest arm of Amikougami lake. A 15-foot test pit has been sunk on a 6 to 10-inch quartz vein striking approximately north astronomic. The vein cuts the basalt which has a schistose zone 8 feet wide with 1 to 3 inch quartz stringers paralleling the main vein. Assays, one from the surface of $18.00 in gold per ton and another from a sample taken across the 8 foot zone at the bottom of the pit of $4.80 in gold per ton, are reported. The vein has been stripped at intervals across the claim.

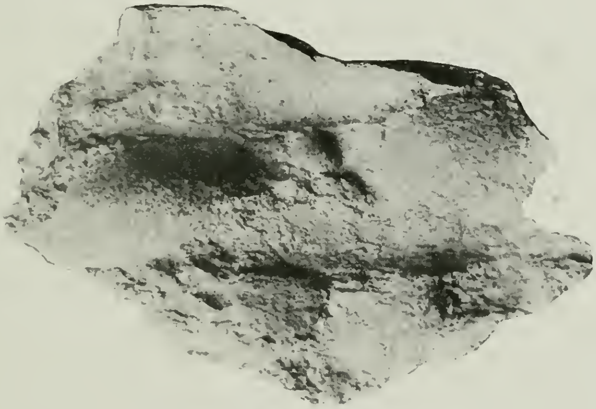
Mosher Claim No. 5834.—The Mosher claim is located about 20 chains east of Lancaster lake. Considerable surface work has been done and a test pit sunk on a vein junction located on the northeast of the claim. One vein, 5 inches wide strikes south 45 deg. east magnetic and dips 70 deg. to the southwest. It is located in a shear zone 5 feet wide. The foot-wall of this vein is volcanic fragmental and the hanging-wall is basalt. A channel sample across 18 inches including this vein gave no values in gold or silver. The other is a calcite and quartz vein striking north 15 deg. east magnetic and dipping 70 deg. west. Native silver in fine specks is disseminated in this vein. The owner reports an assay of silver, 37.5 ounces, and gold $2.20 per ton.

Challenger Gold Mining Company, Limited.—This group comprises seven unpatented claims situated northwest of Blue mountain. The property is best reached by trail from Bourkes. During the summer of 1920 a small party of men was engaged in clearing, building a camp, and in surface work. Some blasting and 300 feet of stripping has been done on a quartz-calcite vein varying from several inches to a few feet wide, striking south 40 deg. west magnetic. The vein, containing masses of the country rock, follows a contact between pillow lava on the northwest and a diabase dike (pre-Algoman?) on the southeast. There is some mineralization with copper and iron pyrites. A sample taken and forwarded by G. R. Webster—the company's president—to the Provincial Assay Office, Toronto, gave $8.40 in gold per ton. The value of the deposit is not yet determined.

Morrissette

Morrissette township is largely made up of low rolling country with some fine spruce swamps. With the exception of the swamp flanking the Black river and some minor areas, the township did not present many difficulties to travel as was expected from descriptions given to our party. A large sand plain and ridge area exists in the vicinity of the string of spring water lakes north of Nettie lake. A splendid bird's eye view of Morrissette may be had from a prominent hill about the centre of the township. The Black river was paddled and surveyed southward from the north boundary for a couple of miles, and was found to be navigable even in the low water experienced in 1920. A rough trail, the old Lightning river trail, goes northeast from Jack Post camp, north of the three mile post on the southern boundary, to Columbus lake. The trail running from the northeast of Nettie Lake is also supposed to go to Columbus lake, but this trail could only be followed to the creek junction shown on the map. It was surveyed to this point.

Geologically the area about Nettie lake is extremely interesting although to date no discoveries of economic importance have been reported. Along the east shore of Nettie lake is a continuous outcrop of a rusty weathering carbonate schist which is highly metamorphosed clastic rock. The clastic origin is still readily discernible megascopically. From the lake the ground gradually rises to the east, and inland 20 chains or so are numerous outcrops of conglomerate which very closely resemble the Timiskaming conglomerate in adjacent areas. From the relationship of the rusty schist to the conglomerate and from the fact that the strike of the schistosity is the same as that recorded for the Timiskaming series in the Kirkland Lake area this rock was classified as Timiskaming series. The Keewatin and the clastic rocks are both cut by granite-porphyry dikes at many points.



Conglomerate at Nettie lake.

An outcrop of fragmental rock is situated along the trail leading from the cabin at the south end of Nettie lake to the workings on the Martin claim The outcrop consists of an 80-foot hill of pseudo-conglomerate. The matrix is a basaltic rock having a prevailing green color. The pebble and boulder contents consist not only of greenstone and amygdaloidal grey lava, but also pink weathering granite, porphyries and occasionally, red jasper. Some of the pebble and boulder contents are rounded. These may be best seen on the precipitous face on the west side of the hill.

There are numerous dikes of red and grey feldspar-porphyry, granite-porphyry and quartz-porphyry cutting the older formations. The intrusive dikes are confined to the Goodfish Lake, Nettie Lake and Jack Post camp vicinities.

The rocks of Morrissette township are mostly massive and schistose basalts and grey lavas. A high percentage of these are amygdaloidal, and considerable of the basalt has been altered to a rusty weathering carbonate.

Since the claims of the Goodfish lake area have already been amply described by Messrs. Burrows and Hopkins[1] further description will not be given here.

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[1] Ont. Bur. Mines Report, Vol. 25, Part 1, 1916, pp. 260-263.

Archambault (Baissonault) Claim No. L 2632.—This claim is in the vicinity of Goodfish lake, its position being shown on the geological map accompanying this report. A line was cut in the direction of the strike from the gold-bearing zone along the contact of the quartz-porphyry and the basalt, on the Martin claim No. L 2232, to the above claim. A test pit was sunk on what promises to be a continuation of the Martin-Brennan vein. The test pit is on a carbonate zone along the contact between the greenstone and the quartz-porphyry. There is considerable mineralization of molybdenite and other sulphides, and promising assays in gold are reported.

Martin Claim No. L2232.—This claim, near Goodfish lake, has already been described, but at the time of the visit of Messrs. Hopkins and Burrows the shaft was filled with water. Specimens from this claim were seen by the writer showing free gold. The greatest concentration of gold values appears to be along the foot wall, where lamellar native gold occurs with molybdenite.

McKeen Claim No. L5399.—This property is also situated near Goodfish lake. Some trenching and blasting has been done on a belt of quartz-feldspar porphyry intruding a volcanic fragmental country rock which has been greatly altered to a rusty weathering carbonate. Nothing is known of the values obtained. The porphyry and the occurrence generally are similar to other properties in the area.

Martin Claims No. 8311 and No. 8501, Nettie Lake.—These claims are about 15 chains east of Nettie lake. During the summer of 1920 surface work was done on the above claims. As yet no important discovery has been made. A granite porphyry, in places altered to a rusty weathering carbonate, intrudes the clastic rocks, but the basalt-porphyry contact had not as yet (September 1920) been exposed by trenching. The schistose, metamorphosed clastic rocks and the border facies of the porphyry were well mineralized with pyrite in places.

Post Claim No. LL 4868.—Several test pits and a shaft have been sunk on this property which is located along the southern boundary of Morrissette township. The country rock is basalt and this has been intruded by a quartz-porphyry dike striking east and west approximately. The basalt near the contact has been highly altered to a rusty weathering carbonate. Several well-defined veins have been stripped. The shaft, which judging from the dump is 50 to 60 feet deep, has been sunk on a vein near the contact with the quartz-porphyry. The vein is heavily mineralized with sulphides, sphalerite, galena, chalcopyrite and pyrite, some of the chalcopyrite has been altered to malachite and azurite. The gangue is quartz, calcite and barite. The vein gave assays of from 4 to 57 oz. of silver per ton and small quantities in gold. A deposit of sulphides 6 to 8 feet wide, principally pyrrhotite, is located about 600 feet a little west of north from No. two post of the claim. The strike of the mineral body is north 62 degrees east magnetic and the dip about vertical. On the south side the sulphide body is bordered with a 5-foot band of felsite. The wall on the north is much fractured and the fractures filled with ferruginous gouge. Apparently this deposit did not yield favourable assays of gold for only a small test pit was sunk and work discontinued.

Claims in the Vicinity of LL 4868.—In this vicinity a good deal of surface work has been performed. The rock exposures are mainly basalt and are not large. The basalt is often schistose and altered to a rusty weathering carbonate, especially in proximity to the porphyry intrusions. Intrusions of porphyry are numerous. The prevailing strike of the porphyry dikes is east and west. The majority of the veins strike northerly: some cut the the porphyry dikes. As no work was in progress at the time of our visit to this area it is impossible to state whether or not gold or silver values were obtained in sufficient quantities to indicate workable deposits.

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PROVINCE OF ONTARIO
DEPARTMENT OF MINES

Hon. H. Mills, Minister of Mines — Thos. W. Gibson, Deputy Minister

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OF THE

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The Stratigraphy and Paleontology of Toronto and Vicinity

PART II.—THE MOLLUSCOIDEA

By
W. A. Parks and W. S. Dyer

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THE STRATIGRAPHY AND PALEONTOLOGY
OF
TORONTO AND VICINITY

Part 2.—The Molluscoidea

By

W. A. Parks, Ph.D., and W. S. Dyer, B.A.

Introductory Note

Part I of this series appeared as Part VI of the 29th Annual Report of the Ontario Department of Mines: it was prepared by Miss Helen Stewart and dealt exclusively with the Pelecypoda.

The present part treats similarly of the Molluscoidea and it is intended as a scientific revision of the phylum as well as a handbook for the guidance of local collectors.

Future parts will deal with the remaining groups of organisms and with the general stratigraphy and correlation.

The present investigations have been undertaken with the view of establishing with greater accuracy the subdivisions and correlation of the Paleozoic rocks exposed in the vicinity of Toronto. Large collections have been made, more particularly from the following localities: the Don brickyard or quarry; various exposures on the Humber river between Weston and the lake; the old shale pit in Lambton village; exposures on the Mimico river; exposures on the Etobikoke river; and the quarry at the prison farm.

This series of articles deals in the first instance with the fossils without regard to their exact stratigraphic significance and leaves the more important matter of correlation for the last part. This method of treatment is not the most desirable but it has been forced on us by the conditions under which the investigations have been carried on.

The phylum Molluscoidea contains two classes, Bryozoa and Brachiopoda. Of the former, twenty-two species and three varieties have been found in the Toronto rocks; most of these species are already known to science; a few, however. are new or of doubtful affinities. The Brachiopod fauna is small, containing only fifteen species of which probably only two are new and one a new variety. In addition are a few species of uncertain identification.

The illustrations accompanying this article were prepared in part from photomicrographs by the junior author. The drawings were made by the senior author, Helen Coleman, and E. B. S. Logier.

As in the case of Part I the classes Bryozoa and Brachiopoda of Toronto and vicinity will be reviewed in detail without particular reference to the distribution of the different species.—W. A. P.

BRYOZOA

A description of the different species is given hereunder:

Order GYMNOLAEMATA
Sub-order CYCLOSTOMATA
Family CERAMOPORIDAE
Genus CHILOPORELLA, *Ulrich*

CHEILOPORELLA, *Ulrich*. Jour. Cincinnati Soc. Nat. Hist. 5, 1882, p. 157.

The original description of this genus is as follows:

> Forming heavy crusts or rising upward into flabellate fronds. Tubes long, traversed by few straight diaphragms. Cell-apertures ovate. Interstitial cells numerous.

Nickles and Bassler define the genus in more modern terms as follows:

> Zoarium forming parasitic sheets, from which rise flabellate fronds or compressed branches; zooecial tubes long, thin-walled, irregular in shape in immature region, near the surface walls much thickened, diaphragms rarely developed; apertures ovate, lunarium conspicuously elevated; mesopores numerous.

CHILOPORELLA FLABELLATA (*Ulrich*)

Plate I, Figures 1 and 2; Plate II, Figures 1 and 2; Plate V, Figure 12; Plate VI, Figure 11.

FISTULIPORA FLABELLATA, *Ulrich*. Jour. Cincinnati Soc. Nat. Hist. 2, 1879, p. 28, pl. 7, figs. 26, 26a, 26b.
CHILOPORELLA FLABELLATA, *Ulrich* Geol. Surv. Illinois, 8, 1890, p. 381, pl. 39, figs. 5, 5b.
CHILOPORELLA NICHOLSONI, *Nickles and Bassler*. Bull. U.S. Geol. Surv., 173, 1900, p. 207.
CHILOPORELLA FLABELLATA, *Cumings*. 32nd. Ann. Rep. Dep. Geol. Nat. Res. Indiana, 1908, p. 802, pl. 11, figs. 1, 1a; pl. 12, figs. 1, 1b.

The following description is founded on Ulrich's original definition amended by observations on our specimens. The zoarium consists of irregular, fan-like, bifoliate expansions. The thickness usually varies from two to four millimetres. The surface is undulating, being raised into broad and inconspicuous monticules with the zooecial apertures disposed in bent and rather irregular rows. The openings are irregularly round to slightly oval, and are separated by intervals varying from nothing to a space as great or greater, than the diameter of the tubes themselves. An average of three zooecial openings appear in the distance of one millimetre and the interzooecial spaces show the openings of numerous mesopores.

Vertical sections show wide, open tubes and broad interspaces with mesopores in the peripheral region while in the immature region there are no mesopores, but, owing to the inclination of the young cells, cross sections of prostrate tubes. No distinct diaphragms were observed. The mesotheca seems to be composed of very irregular, discontinuous, fluctuating laminae.

Tangential sections show the irregular character of the zooecial tubes, their varying distance apart, the thick walls of the peripheral region, and the aggregation of mesopores into groups in certain parts of the zoarium. Deep tangential sections show the absence of mesopores and the irregularly angular form and unequal size of the zooecia. This is shown slightly in the upper, right hand corner of Plate I, Figure 1.

Chiloporella flabellata occurs in the quarry on the Don in association with *Peronopora vera*, the only other bifoliate bryozoan in our rocks: from this species it is easily distinguished by the greater thickness of the fronds and the coarser character of the surface.

Locality.—Don brickyard, Toronto.
No. 1080 H. R. Royal Ontario Museum of Paleontology.

Genus SPATIOPORA, *Ulrich*

SPATIOPORA, *Ulrich.* Jour. Cincinnati Soc. Nat. Hist., 5, 1882, p. 155.
SPATIOPORA, *Nickles and Bassler.* Bull. U.S. Geol. Surv., 173, 1900, p. 24.

The description of this genus given by Nickles and Bassler is as follows:

> Zoarium forming thin crusts, usually on *Orthoceras;* zooecia very short, nearly direct; apertures irregular, with blunt spines at the angles, no lunarium developed; elevated, elongated maculæ usually a conspicuous feature.

Our collections indicate only one species of *Spatiopora* which appears to be new although it is closely related to a described form.

SPATIOPORA VARIANS, *sp. nov.*

Plate I, Figure 3; Plate V, Figure 10.

The zoaria of this species form thin expansions on the shells of *Orthoceras* and present surfaces which are singularly different in different parts of the encrustation. The apertures are polygonal to slightly crescentic, and seem to be indistinctly arranged in a quincuncial manner from certain centres in the more typical parts of the surface. Measured along the rows about four apertures appear in one millimetre. At varying intervals—three to five millimetres—are groups of larger cells which are scarcely elevated above the general surface. This typical arrangement of the apertures is scarcely to be observed in other parts of the zoarial surface as the zooecia seem to emerge at an angle, with thickened walls, thus giving a crescentic appearance to the apertures and a vermiform aspect to the surface. Under a strong magnifier the walls of the cells seem to be thin except at the angles, where they are greatly thickened and stand up as sharp points.

Tangential sections show irregularly polygonal cells with fairly thick walls throughout but greatly thickened in places. In the thickened portion there is evidence of small angular interspaces and denser nodes which may be acanthopores, In deeper parts of the section there is evidence that the tubes are prostrate in the immature region and that they very quickly turn outwards to the surface. The varying character of the surface is probably due to the cessation of growth, in parts, before the outward turn had been completely effected.

Satisfactory vertical sections cannot be prepared owing to the extreme thinness of the zoarium.

This form is very closely related to *Spatipora maculosa,* Ulrich, and to *S. aspera,* Ulrich. From the former species it may be distinguished by the generally smaller apertures, the less conspicuous clusters of larger cells, the varying character of the surface, and the quincuncial arrangement of the cells.

The resemblance to *S. aspera* is even more striking. In both species the general size of the cells, the distance apart and character of the clusters, and the points at the angles of the tubes are alike. For *S. aspera,* Ulrich does not mention the quincuncial arrangement of the apertures or the varying character of the surface. These seem to be the main points of difference, as our failure to detect acanthopores in the tangential section may be due entirely to the state of preservation of the specimen. It is quite possible that further investigation may establish the identity of the two species.

Locality.—4-foot level, old shale pit, Lambton.
No. 1081 H.R. Royal Ontario Museum of Paleontology.

Sub-order TREPOSTOMATA

Family MONTICULIPORIDAE

Genus Aspidopora, *Ulrich*

Aspidopora, *Ulrich*. Jour. Cincinnati Soc. Nat. Hist., 5, 1882, p. 155; Geol. Surv. Illinois, 8, 1890, p. 373; Geol. Minnesota, 3, 1893, p. 254.

Ulrich's original description of this genus is as follows:

> Very thin free expansions with a concentrically and radially striated epitheca covering the lower side. Composed of (according to age) from one to many unequal convex spaces. Cells gradually increasing in size from the margin of each convex space to near the centre of the same. Interstitial cells numerous. Both kinds of tubes crossed by diaphragms. Spiniform tubuli present.

In the report of the Geological Survey of Minnesota (*op. cit.*) he modifies this description as follows:

> Diaphragms horizontal and closely set in the mesopores, usually wanting in the zooecial tubes, but one or more cystiphragms occur in most of the latter. In previous publications on this genus I did not mention the presence of cystiphragms because these structures seem to be wanting in the type species. My present opinion is that the supposed diaphragms figured by me for *Aspidopora areolata* are really cystiphragms, in part incorrectly drawn.

All later species ascribed to *Aspidopora* are characterized in particular by the presence of cystiphragms and the absence of diaphragms in the zooecial tubes. This feature together with the characteristic manner of growth define the genus *Aspidopora* as at present accepted. It is unfortunate that no further description or figures of the type species, *Aspidopora areolata*, have appeared. The original figures certainly do not suggest the absence of diaphragms or the presence of cystiphragms and despite Ulrich's emendation it seems very unlikely that he would have overlooked in the type species so striking a characteristic.

Our rocks contain several species of *Bryozoa* characterized by discoidal manner of growth. Of these, some are possibly *Amplexopora;* one is ascribed to *Prasopora;* one is thought to belong to *Aspidopora* as defined above; and another is placed under *Mesotrypa*.

Aspidopora *cf.* areolata, *Ulrich*

Plate I, Figure 8; Plate II, Figure 8; Plate VI, Figures 7 and 8.

Aspidopora areolata, *Ulrich*. Jour. Cincinnati, Soc. Nat. Hist., 6, 1883, p. 164, pl. 7, figs. 2, 2c.

Monticulipora areolata, *James*. *Ibid.*, 16, 1894, p. 183.

Ulrich describes the species as follows:

> Zoarium consisting of very thin, convex, free expansions, from .3 to 1.0 of an inch in diameter, and about .025 of an inch in thickness. The under surface is marked with radiating striae, and sometimes with obscure concentric wrinkles. The upper or celluliferous surface presents a variable number of slightly convex and irregularly angular spaces with an average diameter of about .15 inch. At the margin of these convex spaces the cell-apertures are circular, and 1/110 of an inch in diameter. The cell-apertures gradually become broadly elliptical, and larger as the centre of the spaces are approached, where the largest have a diameter of 1/80 inch. The apertures of the cells are often closed by a centrally perforated, thin operculum. The interstitial spaces are occupied by elongated apertures of very shallow interstitial cells. The spiniform tubuli are quite numerous and prominent.
>
> In longitudinal (vertical) sections the proper tubes are prostrate for half their length, when they bend upwards and proceed directly to the surface. Their walls are thin and more or less flexuous, especially upon the concave side of the tube. The interstitial tubes are developed from the upper wall of the prostrate portion of the proper zooecia, and enlarge very rapidly, so as to attain their full size, at the second diaphragm. In the proper tubes the diaphragms are present only in the lower half of the tube where it is crossed by two or three. At their apertures a very thin calcareous line representing the opercula mentioned may sometimes be detected. In the interstitial tubes the diaphragms are crowded. The spiniform tubili are first developed near the cell-apertures, where if carefully looked for a variable number may be detected. A second layer of cells is often found above the first.

> Tangential sections show that the cells have very thin walls, those of adjacent tubes being entirely separated, or in contact only at limited points. Their diameter becomes greater as the centre of the convex spaces or monticules is approached, while they at the same time vary their shape from sub-circular to oval or elliptical. The interstitial spaces are occupied by large, usually hour-glass-shaped interstitial cells, which are occasionally divided into halves by a very faint wall. Comparatively large spiniform tubuli are developed at all the points where the true cells come in contact.

A single specimen from the old shale pit at Lambton so closely conforms to the above description that we have little doubt as to its identification. It must be admitted, however, that the horizon is so far above that of the type that some doubt must be entertained, especially in view of the fact that we were unable to prepare a vertical section without sacrificing the whole of the specimen. The tangential section shows the characteristic appearance as described above. No distinct cystiphragms are to be seen near the surface, but where the section is deep and slightly inclined (right hand side of figures on Plates I and II) there is an indication of cystiphragms in the zooecial tubes and of numerous diaphragms in the mesopores which seem to be more prostrate than one would conclude from the original figures and description.

Locality.—Five-foot level, old shale pits, Lambton.
No. 1082 H.R. Royal Ontario Museum of Paleontology.

Genus Mesotrypa, *Ulrich*

Mesotrypa, *Ulrich*. Geol. Sur. Minnesota, vol. 3, pt. 1, 1892, p. 257.

Ulrich describes this genus as follows:—

> Zoaria hemispheric, conical, or discoidal, generally free, with the lower surface covered by an epitheca. Zooecial tubes prismatic or cylindrical, more or less separated from each other by angular mesopores; internally with oblique and sometimes funnel-shaped diaphragms, that often simulate and probably are to be regarded as peculiarly, modified cystiphragms. Mesopores becoming smaller with age, intersected by numerous diaphragms. Acanthopores generally present, sometimes of large size.

Mesotrypa (?) *sp. nov.*

Of frequent occurrence on the Humber river is a discoidal bryozoan with a concentrically wrinkled epitheca which may attain a diameter of 25 mm. The surface is gently convex and practically smooth; the under side is correspondingly concave. The thickness varies, and superposition of layers is not uncommon; a single layer is generally about one millimetre thick.

The surface shows, in places, sub-quadrate zooecial openings more or less regularly arranged and occurring to the number of nine in the space of two millimetres: in these areas the walls seem to be in contact. In other parts of the sur-surface the openings are larger, more rounded, and separated by distinct interspaces although the zooecia are never completely out of touch with each other.

Tangential sections show that the walls are moderately thick and independent even where the mesopores are absent and the zooecial walls in close contact. Very small acanthopores are sparingly developed. Vertical sections show the zooecial tubes to arise with a slight slant from the basal plate and to proceed almost directly to the surface with walls of practically the same thickness throughout. The zooecial tubes are crossed by numerous irregular diaphragms for about two-thirds of their length; the peripheral third seems to be devoid of internal structures. The diaphragms are slanting and irregular and occasionally simulate cystiphragms. Between the zooecial tubes are numerous mesopores, crossed by close-set, horizontal diaphragms, which continue to the surface. These mesopores show distinct evidence, in places, of narrowing towards the surface of the polyzoarium.

There is little doubt that we have to deal in this instance with discoidal bryozoans that have usually been ascribed to *Amplexopora discoidea,* Nicholson, probably because that author makes the following statement:

> An outwardly similar form occurs in the Hudson River group of Canada; but not having prepared thin sections of this, I am not certain of its identity with the Cincinnati type.[1]

In the Report on the Paleontology of Ontario Nicholson states definitely that *Amplexopora discoidea* occurs at Weston but this publication antedates by several years "The Genus Monticulipora."

That the form under review can not be *Amplexopora discoidea* is proved by the numerous and irregular diaphragms in the zooecial tubes, and by the abundance of mesopores with well developed diaphragms; that it is not *Mesotrypa whiteavesii* is sufficiently indicated by the number and character of the diaphragms of the zooecial tubes and the relative size of the mesopores. The absence of true cystiphragms, the fact that the zooecial tubes are in contact at some points, and the smooth surface of the zoarium will serve to separate this form from *Prasopora donensis.* It is with this species however, that the closest affinities are shown. In vertical section the chief difference is in the total absence or rare occurrence of true cystiphragms in the present form. In tangential sections the difference is more pronounced as *Prasopora donensis* shows rounded zooecial tubes completely isolated by mesopores and crossed by the characteristic crescentic lines of cystiphragms.

The proper generic reference of this species seems to be peculiarly difficult. The distinctness of the tube-walls, with the dark lines of demarkation between, indicates as clearly as we have ever seen the division *Integrata* of Ulrich and Bassler. The numerous mesopores, however, make it impossible to ascribe the form to the family *Amplexoporidae* and the other families of the division are even more remote. The relation to *Prasopora* in the occasional occurrence of cystiphragms, the irregular character of the diaphragms, and the numerous mesopores in some instances tapering to nothing at the surface, strongly suggest *Mesotrypa* and there we provisionally place the species.

The specific characteristics seem to be new but as the description was delayed until after the plates were made we have been unable to include any figures. A specific name, therefore, is not proposed at the present time.

Locality.—Humber river, Toronto.
No. 1200 H. R. Royal Ontario Museum of Paleontology.

Genus Peronopora, *Nicholson*

Peronopora, *Nicholson.* Genus Monticulipora, 1881, pp. 102, 215.
Peronopora, *Ulrich.* Jour. Cincinnati Soc. Nat. Hist., 5, 1882, p. 153.
Peronopora, *Ulrich.* Geol. Surv. Illinois, 8, 1890, p. 370.

The presence of cystiphragms in the mature region is said to be characteristic of all members of the family *Monticuliporidae* but in the case of the genus *Aspidopora* there seems to be a degree of departure from this rule. *Peronopora* and *Prasopora*, the only other genera represented in our collections, show this feature to perfection. Both of these genera show cylindrical to polygonal zooecial tubes with both cystiphragms and diaphragms; they both have mesopores and acanthopores, the former with numerous diaphragms. In *Peronopora* the zoarium is always bifoliate whereas it never assumes this form in *Prasopora.* The cell walls are thicker in *Peronopora.* The genus is thus defined by Ulrich:

> Zoaria bifoliate, the surface even, usually with small maculae. Mesopores and acanthopores varying in number. Cystiphragms abundant, present throughout the mature region in the zooecial tubes. Apertures circular or polygonal. Zooecial walls comparatively thick, sometimes ring-like in transverse section.

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[1] The Genus Monticulipora, p. 195.

PERONOPORA VERA, *Ulrich*

Plate I, Figures 4 and 5: Plate II, Figures 4 and 5; Plate V, Figure 3.

PERONOPORA VERA, *Ulrich*. Amer. Geol., 2, 1888, p. 40.
PERONOPORA VERA, *Nickles*. Bull. Kentucky Geol. Surv., 5, 1905, p. 46, pl. 2, fig. 1.
PERONOPORA VERA, *Cumings*. 32nd. Ann. Rep. Dep. Geol. Nat. Res. Indiana, 1908, p. 867, pl. 22, figs. 2-2b; pl. 31. fig. 5.

Nickles' description is as follows:

> Zoarium consisting of bilaminar fronds from 2 to 6 mm. thick and 10 or more cm. in height. Fronds usually somewhat undulating and occasionally producing fronds at right angles. Some specimens branch rather frequently, others rarely. Surface smooth, except for clusters of larger cells which sometimes rise a little above the general level. Apertures circular, seven or eight of the ordinary size in 2 mm. Apertures in the clusters considerably larger than the others. Usually a large amount of circular or subangular mesopores occupy the rather wide interspaces as well as the angles of junction. Often the centre of a cluster is occupied with a large number of mesopores. In some specimens few mesopores are present. Occasionally a specimen shows a large number of small acanthopores at the surface, these may also be seen in some sections. The zooecia have a very short immature region; in the mature region they have a linear series of overlapping cystiphragms and a few diaphragms.

This species is not uncommon in the quarry on the Don river and has often been mistaken for *Heterotrypa frondosa*. The figures of tangential sections (Plate I, Fig. 4; Plate II, Fig. 4) show the characteristic appearance of true tangential section on the left hand side; on the right hand side the section is deeper and slightly inclined showing both zooecial tubes and mesopores in inclined or longitudinal section. The vertical section, from a photomicrograph, is shown without retouching in Plate II, Figure 5; it is rather confused owing to the impossibility of cutting a section exactly parallel to the various elements. The drawing (Plate I, Figure 5) was made by combining the most typical parts shown by the same thin section. The median plane is marked by a very thin line on both sides of which appear the bases of the zooecial tubes and of the mesopores which seem to alternate with a considerable degree of regularity. The base of the zooecial tube is trapezoidal and small, that of the mesopore is hexagonal and larger. The mesopores are crossed by crowded diaphragms throughout: the zooecial tubes have diaphragms in the lower half and cystiphragms in the upper.

Locality.— Don Valley brickyard, Toronto.
No. 1083 H.R. Royal Ontario Museum of Paleontology.

Genus PRASOPORA, *Nicholson and Etheridge Jr.*

PRASOPORA, *Nicholson and Etheridge Jr.* Ann. Mag. Nat. Hist., 4th Ser., 20, 1877, p. 38.
PRASOPORA, *Ulrich*. Geol. Surv. Illinois, 8. 1890, p. 371.

This genus of the *Monticuliporidae* is defined by Ulrich (*op. cit.*) as follows:

> Zoaria forming hemispheric, discoid, or irregular masses, and, more rarely, thin expansions; usually free, with an epithecal covering on the lower side. Zooecial tubes prismatic or cylindrical, thin-walled, largely separated from each other by small angular mesopores, which are generally quite inconspicuous at the surface. Acanthopores usually present, but only occasionally either numerous or strong. Cystiphragms in all the zooecial tubes. Diaphragms crowded in the mesopores.

PRASOPORA DONENSIS, *sp. nov.*

Plate I, Figures 6 and 7; Plate II, Figures 6 and 7; Plate V, Figure 6;

Plate VI, Figure 2.

The zoarium of this species is circular and free, probably with a concentrically wrinkled epitheca. The diameter ranges from 17 to 20 mm. and the thickness is approximately one millimetre. The upper surface is gently convex and the under surface correspondingly concave. The celluliferous surface shows that the ordinary apertures are arranged in quincuncial rows springing from a number of very ill-defined centres. They are usually hexagonal in outline and occur to the number of four in the space of one millimetre. At intervals of 2.5 to 3 mm. are clusters of larger cells, and at about the same interval occur slightly defined monticules. The clusters and the monticules are not necessarily coincident nor are they necessarily the centres of the quincuncial systems.

Tangential sections show that the ordinary zooecial tubes are nearly or quite circular but that they become elliptical as the centres of the clusters are approached. The walls of the zooecial tubes are comparatively thin and independent, touching each other in the direction of the rows but separated in other directions by a number of large angular mesopores. Cystiphragms appear in nearly every tube. Acanthopores are scarcely to be discerned but there is some evidence of very small ones at the points of junction of the tubes.

Vertical sections, where ideally cut, show about five well-developed cystiphragms and clearly defined diaphragms in the zooecia, the latter being confined to the lower part of the tube. The mesopores are crowded with diaphragms.

This species has decidedly the surface characteristics and manner of growth of the genus *Aspidopora* and approaches very closely to *Aspidopora newberri*, Nicholson. We would without hesitation, ascribe the species to *Aspidopora* were it not for the undoubted diaphragms in the zooecial tubes.

Except for the somewhat larger size, the species closely resembles *Prasopora lenticularis*, Ulrich. The vertical sections are almost identical, but the tangential section of *P. lenticularis* shows a closer spacing of the zooecial tubes and a less development of mesopores. The arrangement of the zooecial tubes in rows is apparently a feature of both species.

Locality.—Don brickyard, Toronto.
No. 1084 H.R. Royal Ontario Museum of Paleontology.

Family HETEROTRYPIDAE

Genus Atactopora, *Ulrich*

Atactopora, *Ulrich*. Jour. Cincinnati Soc. Nat. Hist., 5, 1882, p. 154. *Ibid*, 6, 1883, p. 245.

Ulrich's amended description of this genus is as follows:

> Zoaria parasitically attached to foreign bodies, over which they form thin and expanded crusts, the thickness of which varies according to the number (rarely more than three) of superimposed layers, the latter having an approximately definite thickness. Zooecia with more or less thick walls, and indented or floriform orifices, due to the position of the numerous spiniform tubuili, which in the thick-walled species are developed almost exclusively in the portion of the walls immediately surrounding the visceral cavity. True interstitial cells are wanting. At regular intervals the surface presents subsolid elevated "maculæ" that are granulose and finely pitted, and apparently composed of peculiarly modified or aborted cells. Diaphragms few, always horizontal.

Only one species of this genus has been recognised in the rocks at Toronto, *Atactopora maculata*, described below.

Atactopora maculata, *Ulrich*

Plate I, Figure 10; Plate II, Figures 9 and 10; Plate V, Figure 1; Plate VI, Figure 10.

Atactopora maculata, *Ulrich*. Jour. Cincinnati Soc. Nat. Hist., 2, 1879, p. 121, pl. 12, figs. 2-2c; *ibid.*, 6, 1883, p. 245, pl. 12, figs. 2, 2a.

Ulrich's original description, slightly modernized, is as follows:

> Zoarium parasitic, growing into expanded crusts, which vary in thickness from less than .5 to 4 mm.; the usual thickness is about one millimetre. All the specimens observed are attached to species of *Orthoceras* or *Endoceras*. Surface exhibiting rounded or elongated tuberosities, which are abruptly elevated, and from .5 to 1 mm. in

diameter; sometimes they are arranged in quite regular diagonal lines, but usually are irregularly distributed over the surface; measuring from their centres, the distance that they are apart varies from two to nearly four millimetres; summits of maculae somewhat flattened and compact. Zooecial orifices sub-equal, moderately thin-walled, polygonal, about eight in the space of two millimetres; mesopores few or entirely absent. Superior edges of tube-walls, when well preserved, carrying a few small spines.

Transverse sections show very distinct projections into the zooecia. They number from four to five and are very irregularly distributed. In sections of this kind the maculae present the appearance of clusters of minute tubuli, which undoubtedly is their true nature. In vertical sections the zooecia are usually without diaphragms. though these structures are not infrequently developed in moderate numbers. The maculae appear minutely tubular, and are divided into distinct floors, that run parallel with the outline of the projection of the tuberosities on the surface. In a specimen two millimetres in thickness, there are about five of these floors.

This species is not uncommon in the Don brickyard. Our specimens conform fairly well with the description given. There are, however, three points in which they differ. In the first place our specimens do not seem to be attached to *Orthoceras* or *Endoceras,* but it is quite possible that they grew originally on the shells of the latter genus. Fairly flat pieces have been found which measure two or three inches in length and width. In the second place our vertical sections show a considerable number of downwardly-curved diaphragms in the zooecia; and in the third place we have not found any evidence of superimposed layers.

The photograph of the surface (Plate V, Figure 1) shows well the arrangement of the apertures: the points out of focus are the maculae. The tangential section shown in the photograph (Plate II, Figure 10) shows the dense maculae and the thick walls of the zooecial tubes; it fails, however, to indicate the petaloid character of the openings or the numerous acanthopores. These features are better shown by the drawing (Plate I, Figure 10). Satisfactory photographic reproduction of a vertical section was not obtained: the drawing (Plate II, Figure 9) is fairly typical, but in some places the zooecia are more open towards the surface and the diaphragms fewer.

Locality.—Don brickyard, Toronto.

No. 250 H.R. Royal Ontario Museum of Paleontology.

Genus DEKAYELLA, *Ulrich*

DEKAYELLA, *Ulrich.* Jour. Cincinnati Soc. Nat. Hist., 5, 1882, p.155; *ibid.*, 6, 1883, p. 90.
DEKAYELLA, *Nickels and Bassler.* Bull., U. S. Geol. Surv., 173, 1900, p. 31.

Ulrich's description follows:

Ramose, branches often compressed. Mesopores more or less numerous, often aggregated into irregular maculae. Acanthopores of two kinds; large ones arranged as in *Dekayia*, and a much greater number of small ones. Diaphragms in both sets of tubes straight.

It will be observed that the essential point in distinguishing this genus from the related *Dekayia* and *Heterotrypa* is the presence of two kinds of acanthopores. Cumings maintains that this feature is not confined to *Dekayella* and would make the three genera identical.

DEKAYELLA ULRICHI (*Nicholson*)

Plate I, Figures 9 and 11; Plate V, Figure 9.

CHAETETES FLETCHERI, *Nicholson.* Quart. Jour. Geol. Soc. London, 30, 1874, p. 504, pl. 29, figs. 6, 6a; Pal. Ohio, 2, 1875, p. 197, pl. 21, figs. 7, 7a.
MONTICULIPORA (HETEROTRYPA) ULRICHI, *Nicholson.* Genus Monticulipora, 1881, p. 131, fig. 22.
DEKAYELLA ULRICHI, *Ulrich.* Jour. Cincinnati Soc. Nat. Hist., 6, 1883, pp. 91, 153.
DEKAYIA ULRICHI, *Cumings.* 32nd Rep. Geol. Nat. Res. Indiana, 1908, p. 824, pl. 14, figs. 4, 4b; pl. 28, fig. 7.

Nicholson's original description with some few terms modernized follows:

Zoarium ramose, of cylindrical or sub-cylindrical branches, which divide dichotomously at irregular intervals, and vary in diameter from less than four to about eight millimetres. The surface is smooth and destitute of monticules, but in well-preserved specimens minutely spinous; the calices sub-polygonal or rounded, mostly .25 mm. or slightly more in diameter. Interspersed with the openings of the ordinary zooecia are the minutely irregular apertures of a largely developed series of small mesopores.

As regards internal structure, the corallites are at first thin-walled, but become thickened in the outer part of their course, their walls becoming at the same time seemingly fused together. The mesopores occupy all the intervals left between the oval or rounded larger tubes, and there is a largely developed series of thick-walled hollow acanthopores, placed at the angles of junction of the zooecia. Diaphragms are wanting, or are very sparingly developed in the axial region of the branches, but are abundantly present in the outer portion of the tubes, and are much more closely set in the mesopores than in the zooecia. In all cases, the diaphragms are complete and approximately horizontal.

Ulrich removed the species to his new genus *Dekayella* on account of the presence of two kinds of acanthopores, large and small. The former originate in the immature region while the latter appear only in the mature or superficial region.

This species has long been considered as one of the most typical fossils from the Don river; it has been identified by more than one author; and has been regarded as the chief evidence of the Eden age of these beds. While we are not prepared, in the face of many statements to the contrary, to deny the occurrence of this form, we fail to find among many dozens of thin sections any definite evidence of its occurrence. Nearly every specimen which has been ascribed in our collections to this species turns out on microscopic examination to be *Hallopora subplana*. As the surface is in every instance obscured by hard shale in the apertures, the identification has been made merely from the shape of the zoarium which is indistinguishable from that of *Hallopora subplana.*

While we are unable at present to include this species with certainty it is thought advisable to refer to it in view of what has been said above. Nicholson's original figures are reproduced herewith: it will be observed that the tangential section does not show the two kinds of acanthopores.

Genus LEPTOTRYPA, *Ulrich*

LEPTOTRYPA, *Ulrich*. Jour. Cincinnati Soc. Nat. Hist., 6, 1883, p. 158; Geol. Surv. Illinois, 8, 1890, pp. 377, 455; Geol. Minnesota, 3, 1893, p. 316.
LEPTOTRYPA, *Simpson*. 14th Ann. Rep. State Geol. Surv., N.Y. for 1894, 1897, p. 580.
LEPTOTRYPA, *Nickles and Bassler*. U.S. National Museum, Bull., 92, 1915, p. 717. (*See* for fuller synonymy.)

Leptotrypa is an incrusting form of *Heterotrypidae* defined as follows:

Zoarium incrusting, often assuming cylindrical, discoidal, or other forms; zooecial tubes polygonal, with thin walls, and few or no diaphragms; acanthopores small, never abundant; no mesopores.

LEPTOTRYPA EXPANSA, *sp. nov.*

Plate I, Figure 12; Plate II, Figure 3.

Our collection contains one good specimen of an exceedingly fine-grained, incrusting bryozoan covering the surface of a flattened fragment of *Orthoceras*, 80 mm. by 30 mm. in extent. The surface shows polygonal apertures to the number of five or six in a millimetre. In well preserved parts delicate but distinct spines are to be observed at the angles of the zooecial openings. At intervals of two millimetres are small clusters of slightly larger cells raised into monticules. These elevations are arranged more or less in diagonal lines.

Tangential sections indicate thin-walled zooecial tubes, strictly polygonal, and with coalesced walls where in contact with one another. Where not in contact the zooecial wall is rounded and only about one half the thickness of the coalesced walls (not well shown in the diagram). The interspaces, therefore, vary in size, are not very numerous, and are always bounded by convex sides. Acanthopores occur at the angles of junction of the zooecial walls but by no means at every such angle. Occasionally a small acanthopore is seen in the wall: it seems to belong to one proper wall and to project slightly into the zooecial space on that side. Satisfactory vertical sections were not secured, but inclined parts of the tangential section indicate that the tubes are inclined or prostrate in the immature region and without diaphragms. The varying size of the interspaces and their lack of true walls leads to the conclusion that they are not to be interpreted as mesopores.

This species is closely related to *Leptotrypa minima,* Ulrich, with which it agrees in the character of the surface, spacing of the monticules, and intimate structure of the zoarium for the most part. It differs, however, in that the monticules are not formed of smaller cells than the average but of larger. The zoarium is of greater size and is not always attached to a small species of *Orthoceras* "from .3 to .6 of an inch in diameter at the larger end."

Locality.—Four-foot level, old shale pits, Lambton.
No. 1085 H.R. Royal Ontario Museum of Paleontology.

Genus STIGMATELLA, *Ulrich and Bassler*

STIGMATELLA, *Ulrich and Bassler.* Smiths. Misc. Coll., 47, 1904, pp. 24, 33.

The description is as follows:

> Zoarium incrusting, massive or sub-ramose; mesopores present, often restricted to small spots; acanthopores small, more or less abundantly developed at intervals between which they are wanting; in ramose forms they are developed in the extreme outer region.

The more extended description by the same authors is given below:

> Zoarium variable, ranging from incrusting to irregularly massive and ramose. Zooecia angular, rounded, or irregularly petaloid, the shape depending upon the presence (or absence) of mesopores and the number of acanthopores. Typically the zoarial surface exhibits at regular intervals maculae or spots composed of mesopores, although in some species the usual monticules or clusters of large cells appear. Acanthopores always present but variable in number, intermittent, developed chiefly in narrow zones, sometimes inconspicuous but more often so numerous as to give the surface a decidedly hirsute appearance. Mesopores, when present, developed in mature region only, their number being variable even for the same species.
>
> The zooecial tubes have thin walls in the axial region and these become but slightly thickened in the peripheral region where a few unusually delicate diaphragms are inserted. In vertical sections the walls exhibit at rather regular intervals in the peripheral region thickenings somewhat similar to those occurring in *Stenopora.* These thickenings occur approximately at the same height in the wall, and tangential sections through these zones give the full development of acanthopores. Minute structure of walls as shown in tangential sections, of the type that characterizes the *Heterotrypidae.*

Representatives of this genus are among the commonest fossils of the Toronto rocks, but, owing to the varying shape of the zoaria and the differing manner of growth, they are among the most difficult to recognize. Ramose, encrusting, irregular, "puff-ball," and many other types are of common occurrence. In nearly every instance sections are necessary in order to make even an approximate identification. We recognize eight more or less distinct types, but in all probability further detailed work would reveal more. Three of our forms agree fairly well with described species, and three others are thought to represent varieties of another species. Two new species have been created.

STIGMATELLA CRENULATA, *Ulrich and Bassler*

Plate III, Figures 4, 5 and 7; Plate IV, Figures 4 and 5.

STIGMATELLA CRENULATA, *Ulrich and Bassler*. Smiths. Misc. Coll., Quart., 47, 1904, p. 34 pl. 9, figs. 1-4; pl. 14, figs. 1, 2.
STIGMATELLA CRENULATA, *Cumings*. 32nd Ann. Rep. Dep. Geol. Nat. Res. Indiana, 1908, p. 882, pl. 24, figs. 4-4d.
STIGMATELLA CRENULATA, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 1193.

The original description of this species follows:

> Zoarium composed of cylindrical, subcylindrical or compressed, frequently dividing stems 10 mm. or more in diameter, arising from a broad base and forming a clump probably seldom more than 50 mm. high. Surface even, but in well-preserved mature specimens spinulose because of the many acanthopores. Maculae well marked, generally composed of mesopores which make up the characteristic "spots" but sometimes formed exclusively of zooecia larger than the ordinary. Zooecial apertures small, about 9 in two mm. with their walls thin and often beautifully inflected by the numerous small acanthopores. Mesopores present, variable in number but usually few and mostly aggregated in the maculae. In the axial region the zooecial tubes have thin finely crenulated walls and occasionally a diaphragm or two. In the mature region the walls increase slightly in thickness, mesopores and acanthopores develop, and thin diaphragms cross the zooecial tubes and mesopores at varying but always comparatively remote intervals.

This is a common species on the Humber river, Toronto. We are unable to add anything to the description given and every feature mentioned by the authors has been observed.

Plate III, Figure 5 was drawn from a photograph of a part showing a macula near the bottom; Plate IV, Figure 5 is a photographic reproduction of a section showing no maculae but with the mesopores more scattered. Plate III, Figure 7 is copied from Nickles and Bassler but in no way differs from our sections.

Locality.—Humber river, Toronto.

No. 1086 H.R. Royal Ontario Museum of Paleontology.

STIGMATELLA CATENULATA, *Cumings and Galloway*

Plate III, Figures 1, 1a, 2 and 3; Plate IV, Figures 1, 2, 3.

STIGMATELLA CATENULATA. *Cumings and Galloway*. 37th Ann. Rep. Dep Geol. Nat. Res., Indiana. 1913. p. 437, pl. 19, figs. 1-1c.

This species is described as follows:

> Zoarium robust, subramose 1.5 to 2 cm. in diameter and 5 or 6 cm. long. Surface nearly smooth, with low round monticules or large maculae, composed of mesopores and large zooecia. Zooecia subcircular, with medium thin walls. Mesopores are usually restricted to the clusters, but sometimes, on immature branches, there may be a small area on which the mesopores are numerous.
>
> Tangential sections show the zooecia to be subpolygonal and thin-walled, with a light coloured intermural line; 9 zooecia in 2 mm. Where there are mesopores the zooecia are smaller, but there is the same number in 2 mm. including mesopores. The acanthopores are small but conspicuous, about 1/40 mm. in diameter, about 10 in 10 zooecia. They are situated at the angles of junction of the zooecia and never inflect the zooecial wall. Mesopores are usually few or absent in sections near the surface, but occasionally a section will show a region of numerous mesopores, especially if the section is deep or taken from an immature branch.
>
> Diaphragms are absent in the axial region and there are only one or two in the mature region. The zooecial walls are only slightly thickened in the mature region, which is 2 or 3 mm. in depth. The chain-like mesopores are the noticeable feature of longitudinal sections. They begin in the submature region and ordinarily do not reach the surface. Where the diaphragms cross the mesopores there is a constriction, giving to the mesopores the appearance of chains or strings of beads. The zooecial walls are nearly straight or only slightly flexuous.

Species of *Stigmatella* showing distinct chain-like mesopores are of frequent occurrence in the rocks at Toronto. The only species in which this character is pronounced are *S. interporosa,* Ulrich and Bassler, *S. sessilis,* Cumings and Galloway, and *S. catenulata.* All of our specimens are distinct from S. *interporosa* as the great development of mesopores characteristic of that species is not seen. One of them resembles *S. sessilis,* and three others approach so close to *S. catenulata* that they are included in that species although varietal differences are marked.

The first type which we may call variety (a) approaches most closely to typical *S. catenulata.* The zoarium is irregularly ramose, with flattened branches which appear to be hollow. An average branch is about 15 mm. by 8 mm. The surface is marked by very small and inconspicuous monticules, 2 to 3 mm. apart.

Tangential sections show groups of larger, thin-walled, polygonal zooecia to the number of nine in a space of two millimetres, and areas with considerably smaller and more rounded zooecia with frequent mesopores. As many as twelve zooecia were counted in the space of two millimetres. Sections very near the surface present almost exactly the appearance of Cumings and Galloway's figures except that the acanthopores are not rigidly confined to the angles of the zooecia. Sections at moderate depth show scattered large acanthopores; many of them not at the angles of junction, and often strongly inflecting the zooecial cavity (Plate III, Figure 1). Sections cut at a still deeper level are almost devoid of acanthopores.

Vertical sections show that the tube-walls increase very little in thickness towards the surface and that the characteristic chain-like mesopores are well developed. Diaphragms in the zooecial tubes are of rare occurrence.

This variety differs from the type only in the character of the acanthopores and in the more rugose surface.

A second variety (b) which it seems impossible to remove from this species has grown around a small crinoid stem to a length of 80 mm. and a total thickness of 25 mm. The surface is nearly smooth but has, nevertheless, low inconspicuous elevations at wider intervals than in the last variety.

Tangential sections show the large and small zooecial tubes, as in variety (a), with a slightly greater tendency to rounded form in the small zooecia. The acanthopores are small and practically confined to the angles of the zooecia; in fact, the section is not to be distinguished from that of the type.

Vertical sections likewise are very like those of the type. The mesopores are rather coarser than in variety (a) and there are more diaphragms. These structures, however, are of such tenuity, that they may have broken down in variety (a).

This variety differs from the type chiefly in the manner of growth as it is distinctly incrusting on a crinoid stem and shows no indication of ramose habit.

Variety (a)

Locality.—Five-foot level, Lambton shale pits.

No. 1097 H.R. Royal Ontario Museum of Paleontology.

Variety (b)

Locality.—Seven-foot level, Lambton shale pits.

No. 1088 H.R. Royal Ontario Museum of Paleontology.

A third form ascribed to this species, variety (c), is so distinctive that it should, perhaps, be described as a new species. The prominent chain-like mesopores and the slight dissimilarity in vertical section, induce us to retain it under *S. catenulata* but with a definite varietal name as below.

STIGMATELLA CATENULATA DIVERSA, *var nov.*

Plate III, Figures 8, 8a.

The main portion of the zoarium of this variety is a roughly spindle-shaped mass about 40 mm. long and 20 mm. wide at the middle. From this central mass a few branches seem to have been given off but as they are broken away nothing can be said as to their length. The surface is covered with large rounded monticules at intervals of about five millimetres. The apertures of the zooecia between the monticules are fine and regular but on the summits a great diversity in size is to be observed.

Vertical sections are scarcely to be distinguished from those of the two varieties described above except for the presence of more numerous diaphragms. With regard to the chain-like mesopores a critical examination shows the following features in the three varieties:—

Variety (*a*) Mesopores, numerous, large, well developed in the mature region.

Variety (*b*) Mesopores, smaller, less numerous, and scarcely developed in the mature region.

Variey (*c*) (STIGMATELLA CATENULATA DIVERSA). Mesopores few, except in restricted areas, not well developed in the mature region; zooecial walls crenulated and passing into the chain-like mesopores in the immature region.

Tangential sections (Plate III, Figures 8 and 8a) are very distinctive. The general field shows regular, polygonal, thin-walled zooecia to an average number of ten or eleven in the space of two millimetres. In this region mesopores are very few and small. Acanthopores are well developed, usually, but not always, at the angles of junction of the zooecial walls and sometimes slightly inflecting the tubes. At intervals of about five millimetres the structure is distinctly different (Figure 8) as the zooecial tubes are large and rounded, the mesopores numerous and of very irregular shape, and acanthopores practically absent.

Externally this variety can easily be recognized by the large rounded monticules; in tangential section the structure as described above is unique; in vertical section, it is difficut to separate from the other varieties, particularly that described as variety (b).

Locality.—Humber river, Weston, Ontario.
No. 1089 H.R. Royal Ontario Museum of Paleontology.

STIGMATELLA LAMBTONENSIS, *sp. nov.*

Plate II, Figure 13.

This species is founded on a single specimen from the old shale pit at Lambton, The zoarium is ramose with flattened branches arising from a common clump: an average branch is about 12 mm. by 7 mm. The general aspect of the branching zoarium is less robust than in the specimens which we have ascribed to *Stigmatella crenulata* but otherwise it is very similar.

The surface is smooth and apparently without maculae but it is of insufficient extent and too poorly preserved to justify the statement that maculae are absent.

Vertical sections (Plate II, Fig. 13) show about five zooecial tubes to the millimetre and well illustrate the periodical thickening of the walls characteristic of the genus. Diaphragms are fairly numerous and very irregular showing curvature, and, in some cases, a high inclination to the zooecial walls. Mesopores are infrequent, chain-like, and sharply defined. They have very thick walls and extend, in some cases, into the mature region. The lower part of the figure is not cut parallel to the direction of the tubes: other sections show that the walls are thin in the immature region and with few diaphragms.

Tangential sections are very like those of *Stigmatella crenulata* showing polygonal zooecial tubes, scattered angular mesopores and an occasional spot of aggregated mesopores. Acanthopores are large and abundant and are nearly always situated at the angles of the zooecial tubes. Near the surface where the zooecial walls are thick the acanthopores do not inflect the tube-walls, but deeper down, where the walls are thin, a distinct inflection is observed.

In many respects this species resembles *Stigmatella crenulata*, but the crenulated walls of that species are never seen. In vertical section it is almost identical with *Stigmatella sessilis*, Cumings and Galloway.[1] At first we were inclined to regard the present species as identical with *S. sessilis* but the very different manner of growth seems to make its separation necessary.

Locality.—Five-foot level, old shale pit, Lambton, Ontario.

No. 1090. H.R. Royal Ontario Museum of Paleontology.

STIGMATELLA VULGARIS, *sp. nov.*

Plate I, Figures 13 and 14; Plate VI, Figure 12.

In the Don Valley brickyard one of the commonest fossils is the "puff-ball". This seems to be a variable species of *Stigmatella* of which the zoarium is of considerable size, massive, nodose, subhemispherical, or even thick discoidal in shape. The appearance of the specimen which is selected as a type is indicated in Plate VI, Figure 12. This specimen measures 80 mm. by 55 mm. by 30 mm. Other examples, of a roughly hemispherical shape, frequently measure 50 mm. in width and 20 or 25 mm. in height. While it is quite possible that more than one variety or even species is represented by the various specimens, we have not been able to recognize constant features by means of which they can be differentiated.

The surface of the type is smooth, and maculae are indicated only by clusters of larger cells very indistinctly developed at intervals. Tangential sections very near the surface (Plate I, Fig. 13) show zooecia of very irregular shape and size with thick walls and numerous large acanthopores. We are inclined to regard the smaller cells as young zooecia rather than as mesopores. In places, the cells are somewhat larger but no other difference is observed. Deep tangential sections are strikingly different: the same irregular character of the tubes is seen, but the walls are extremely thin and the acanthopores less numerous and very small (Plate I, Fig. 14).

Vertical sections show very thin-walled zooecia crossed by a few distinct diaphragms chiefly in the peripheral zone. No structures which can be interpreted as distinct mesopores are seen. In places the walls are crenulated and in others quite straight. The structure is intermediate between that of *Stigmatella crenulata* and *S. personata*. It may be regarded as intermediate between figures 4 and 6 of Plate III.

The hemispherical examples of this species show no difference in vertical sections, but tangential sections are almost devoid of acanthopores, and groups of larger cells are more distinctly developed; in some cases very large zooecia appear among the smaller ones. In one case the surface is distinctly monticulose but the sections do not differ in any distinct manner.

Locality.—Don brickyard, Toronto.

No. 1091 H.R. Royal Ontario Museum of Paleontology.

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[1] Dept. Geol. Nat. Res. Indiana, 37th. Rep. 1913. p. 439. pl. 19, fig. 3; pl. 20, fig. 2-2b.

Stigmatella *cf.* personata, *Ulrich and Bassler*

Plate III, Figure 6; Plate IV, Figures 6 and 7.

Stigmatella personata, *Ulrich and Bassler.* Smiths. Misc. Coll., Quart. 47, 1904, p. 36, pl. 12, figs. 1-3.

Stigmatella personata, *Cumings.* 32nd Ann. Rep. Dept. Geol. Nat. Res. Indiana, 1908, p. 884, pl. 24, figs. 3, 3d.

The original description of this species is as follows:

> This is one of the non-mesopored species of the genus and forms smooth branching zoaria very much like *S. crenulata* and *S. spinosa.* From the former it is distinguished by having fewer acanthopores, and in lacking the crenulation of the walls in the immature region. From *S. spinosa* it is separated by its larger zooecia, 7 to 8 being found in 2 mm. while 10 are required in that species to cover an equal distance.. The acanthopores in *S. Personata* also afford a difference, being but seldom more numerous than the junction angles which they usually occupy. In *S. spinosa*, it will be remembered, they are so abundant that they almost completely surround the zooecium.

Ulrich and Bassler record this species as uncommon in the Richmond formation at Hanover, Ohio. Cumings recognizes it in a single specimen from the top of the Richmond series on Elkhorn creek, near Richmond, Indiana.

Associated with *Stigmatella crenulata* on the Humber river are a number of coarsely ramose forms, externally very like that species. The branches arise from a clump-like base and are frequently twenty millimetres in greater diameter. The surface is almost smooth but generally shows irregular, very low, rounded monticules, which we have used to differentiate the two species externally. Tangential sections (Plate IV, Fig. 7) show angular zooecia of variable size, in some places as few as 7 in 2 mm. but generally more numerous. Small acanthopores occur at the angles of junction of the zooecia in certain parts of the sections, in others they are practically absent.

Vertical sections show the straight, uncrenulated zooecial walls characteristic of the species, but in the immature region there is sometimes a slight degree of crenulation. Diaphragms are very few in most cases and are more common in the mature region.

The lower horizon of these forms makes us somewhat doubtful in ascribing them to *S. personata* but they certainly approach closer to that species than to any other described form. *S. personata*, *S. crenulata* and the form we have described as *S. vulgaris* seem to be much alike. They differ in the manner of growth, the slight variation in the smaller tubes (mesopores ?) and more particularly in the degree of crenulation of the zooecial walls.

Locality.—Old shale pits. Lambton; Humber river, Lambton.
Nos. 1092, 1093 H.R. Royal Ontario Museum of Paleontology.

Stigmatella *cf.* clavis (*Ulrich*)

Leptotrypa clavis, *Ulrich.* Jour. Cin. Soc. Nat. Hist., 6, 1883. p. 161, pl. vi, figs. 3, 3a

Stigmatella clavis, *Ulrich and Bassler.* Smith's Misc. Coll., Quart., 47, 1904, p. 34, pl. 10, fig. 4.

Stigmatella clavis, *Cumings.* 32nd Ann. Rep. Dept. Geol. Nat. Res. Indiana, 1908, p. 881, pl. 24, figs. 2, 2a; pl. 25, fig. 3.

> Zoarium growing parasitically, usually upon crinoid columns, but not infrequently on the stems of small branching bryozoa. In thickness it varies from .02 to .15 of an inch, the largest species seen being about one inch in length. Those growing upon the crinoid columns usually being club-shaped or subfusiform, while those upon other objects are variously and irregularly shaped. Surface presenting at intervals of .1 inch, small clusters of cells a little larger than the average, which in a few specimens are slightly elevated above the general level of the surface. Cells of one kind only, rather unequal in size, and irregular in arrangement, with moderately thin walls, and an average diameter of 1/130th of an inch, while the diameter of those in the

groups seldom exceeds 1/100th of an inch. When in a good state of preservation zooarium has a characteristically hirsute appearance.

Longitudinal sections show a spiniform tubulus between nearly all of the thin and straight tube-walls. Their internal cavity is distinctly shown and comparatively large. Diaphragms are usually developed at remote intervals, though often wanting. No interstitial tubes have been observed.

In tangential sections the cells are seen to be thin-walled and of rather unequal size. Spiniform tubuli of moderate size are plentifully developed, placed at the cell angles, and often at points between, in which case the walls are forced into their respective cell cavities on each side. No special series of small cells are observed in these sections.

This species is most nearly allied to *S. ornata*, from which it differs principally in having more numerous spiniform tubuli, which are also much more conspicuous, both externally and internally. These differences will also apply to the other species.

Among the specimens collected from the Humbervale quarry are a few rather poorly preserved examples showing the club-shaped zoarium characteristic of *S.clavis*. Sections show that these zoaria are parasitic on stems of *Bythopora arctipora* and indicate some differences from any other of the species of *Stigmatella*.

The groups of larger cells characteristic of the species have not been observed owing to the poor state of preservation of the surface. Tangential sections show the numerous, fairly large, sometimes hollow acanthopores indenting the walls of the zooecia.

Vertical sections closely resemble those of *S.clavis,* in the rather irregular character of the zooecia and the evidence of a cavity in the acanthopores. Certain parts of the section show nothing to cause one to doubt the identity of our form with *S.clavis,* but in other parts, the occurence of chain-like mesopores in the immature region constitutes an important difference which might justify the removal of the form to *S.catenulata* with the rank of a variety. However, the club-like shape of the zoarium, and the general resemblance in section so strongly suggest *S.clavis* that it is thought best to provisionally refer the form to that species. If the description of *S. clavis* could be amended to include a few chain-like mesopores in certain parts of the immature region there would be little doubt as to the indentity of our specimens with the type of the species.

The collections contain also some specimens of *Stigmatella* encrusting on shells of brachiopods which in both vertical and tangential section can scarcely be distinguished from *S.clavis* as defined above, *i.e.* with a few chain-like mesopores in the immature region.

Locality.—16-foot level, Humbervale quarry.

No. 1183 H.R. Royal Ontario Museum of Paleontology.

Family BATOSTOMELLIDAE

Genus Bythopora, *Miller and Dyer*

Bythopora, *Miller and Dyer.* Contr. to Pal., No. 2, p. 6.

Bythopora, *Nickles and Bassler.* Bull. U.S. Geol., Surv., 173, 1900, p. 32.

The amended description of this genus as given by Nickles and Bassler is as follows:

> Zoarium ramose; branches usually slender, sometimes of considerable size; zooecia practically without diaphragms; apertures oblique, narrowing above; interspaces canaliculate; mesopores few; acanthopores comparatively strong, rarely more than one to each zooecium, sometimes wanting.

Bythopora arctipora (*Nicholson*)

Plate II, Fig. 12; Plate V, Figure 11; Plate VI, Figure 3.

Ptilodictya (?) arctipora, *Nicholson.* Annal. Mag. Nat. Hist. 4th series, 15, 1875, p. 180. pl. 14, figs. 4-4b; Pal. Ohio, 2, 1875, p. 262, pl. 25, figs 9-9b.

Bythopora arctipora, *Miller and Dyer.* Contr. to Pal., No. 2, p. 6. 1878.

Bythopora arctipora, *Cumings.* 32nd Ann. Rep. Dept. Geol. Nat. Res. Indiana, 1908, p. 780, pl. 8, fig. 8, pl. 26, figs. 15, 15a.

Nicholson's description is as follows:

> Polyzoary forming a cylindrical, slightly branched frond, which is not sharp-edged, exhibits no non-celluliferous borders, and shows no traces of a central laminar axis. Cells arranged in obscurely longitudinal, alternating rows, apparently perpendicular to the surface, and radiating in all directions from an imaginary axis. Cell-mouths very much compressed, much longer than wide, expanded below, and attenuated superiorly, where they are often somewhat twisted and bent. Upon the whole the cells are pyriform in shape, with their narrow ends directed upwards, about eight in the space of one line measured vertically, and twelve in the same space measured diagonally. The cells are not always in contact, especially in their upper portion, and their borders are always distinctly marked off by impressed lines; but they are not arranged between elevated longitudinal lines. The margins of the cells are very thick and conspicuous, not granulated, tuberculated, or spinigerous.
>
> The best preserved fragment had a length of eight and a half lines, dividing at its summit into two branches, its diameter being rather more than one-third of a line.

Delicate branching Bryozoa are among the commonest fossils both on the Humber and Don rivers but it is very seldom that the surface is well enough preserved to make the identification certain. There is no doubt, however, that most of the forms are referable to *B. arctipora,* but some, particularly on the Humber river, *may* be *B. delicatula,* Nicholson.

Locality.—Don Valley brickyard, Toronto; Lambton.

Nos. 1087 H.R., 1094 H.R., 1095 H.R. Royal Ontario Museum of Paleontology.

Bythopora *cf.* delicatula, *Nicholson*

Plate VI, Figure 4.

Chaetetes delicatulus, *Nicholson.* Quart. Jour. Geol. Soc. London, 30, 1874, p. 505, pl. 29, figs. 8-8b; Pal. Ohio, 2, 1875, p. 199, pl. 21, figs. 9-9a; Pal. Prov. Ontario, 1875, p. 30.

Monticulipora delicatula, *James and James.* Jour. Cin. Soc. Nat. Hist., 10, 1888 p. 178; Miller, N. A. Geol. Pal., 1889, p. 197, fig. 196.

Bythopora (?) delicatula, *Ulrich.* Cont. Micro. Pal., Cambro-Sil., pt. 2, 1889, p. 36.

Bythopora delicatula, *Whiteaves,* Pal. Fossils, 3, 1895, p. 116.

Bythopora delicatula, *Cumings.* 32nd Ann. Rep. Dept. Geol. Nat. Res. Indiana, 1908, p. 781, pl. 8, fig. 7; pl. 27, fig. 1.

Nicholson's original description of this species follows:

> Corallum very slender and delicate, ramose, of cylindrical stems, which terminate sometimes in thickened, rounded extremities, and which in some cases appear to spring from a horizontal footstalk. Stems sometimes simple, more commonly bent, the divisions taking place dichotomously at acute angles. Diameter of the stems usually about half a line, sometimes a quarter of a line, rarely two-thirds of a line. Corallites very oblique to the surface of the coral, opening by oval apertures, the length of which corresponds with the long axis of the stem and uniformly exceeds the breadth. Calices in diagonal rows about eight in one line, measured longitudinally, and twelve to fourteen in the same space measured diagonally. The calices are all of equal size, and when perfect the lower lip is more or less thin and prominent. The surface is entirely devoid of monticules or elevations of any kind, and there are no very minute tubuli amongst the ordinary corallites.

Nicholson states that this species is one of the commonest fossils in the Hudson River group both in Canada and the United States and records its occurrence at Weston, Toronto, Credit river, Georgian bay etc. Nickles and Bassler give its horizon as Richmond and Ulrich found it on a slab from Stony mountain, Manitoba. The old collections of the University of Toronto contain many specimens from the

Humber river which were ascribed to this species but we are of the opinion that all of these, except one, are *Bythopora arctipora.* It seems unlikely that Nicholson could have confused two of his own species but we are forced to admit that we have been unable to identify *B. delicatula* in the very large collections made from the vicinity of Toronto. One specimen from Weston, figured herewith, has been recorded as *Bythopora gracilis* which it certainly is not. This form is more robust than *B. arctipora* and closely resembles specimens of *B. delicatula* from the Richmond of Oregonia, Ohio. This form is provisionally ascribed to the present species.

Locality.— Weston, Ontario.

No. 1096 H.R. Royal Ontario Museum of Paleontology.

BYTHOPORA GRACILIS, *James*

This species of *Bythopora* is a ramose form, much more robust than either *B. arctipora* or *B. delicatula.* The apertures are oval to circular and are separated in part, by minute circular tubuli. As the species has been recorded from the district it is mentioned here but we have been unable to identify the form.

Family HALLOPORIDAE

Genus HALLOPORA, *Bassler*

CALLOPORA, *Hall.* Pal. New York, 2, 1852, p. 144.
CALLOPORA, *Nicholson.* Pal. Prov. Ont., 1874, p. 61; Geol. Mag., new series, 1, 1874, p. 13.
CALLOPORA, *Hall.* 28th Ann. Rep. N.Y. State Mus., 1879, p. 114.
CALLOPORA, *Ulrich.* Jour. Cin. Soc. Nat. Hist., 5, 1882, p. 154, 251.
CALLOPORA *Cumings.* 32nd Ann. Rep. Dept. Geol. Nat. Res. Indiana, 1908, p. 741.
HALLOPORA, *Bassler.* Bull. U.S. Nat. Mus., 77, 1911, p. 325, 326.
HALLOPORA, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 72. (See for complete synonomy).

Ulrich's amended description of the genus *Callopora* is as follows:

> Zoarium usually ramose, the branches frequently anastomosing and forming bushy clumps; zooecia at first prismatic, four to eight sided, gradually becoming cylindrical in most cases; at first with closely set diaphragms, then diaphragms more distant, finally in the mature region diaphragms usually closely set; apertures closed at times by perforated, often ornamented covers; mesopores more or less numerous, angular, crowded with diaphragms.

Bassler (*op. cit.*) points out that the name *Callopora* was preoccupied by Gray with *Callopora lineata* as the type of the genus. In consequence of this he has proposed the name *Hallopora* to replace *Callopora* as used by Hall.

The rocks of Toronto contain at least three species of *Hallopora,* all ramose: in two cases, the surface is smooth or nearly so, and in the other case it is covered with distinct monticules. The larger of the smooth species is referred to *Hallopora subplana,* Ulrich, or to *H. onealli communis,* and the smaller to *H. onealli.* The one with monticules is herein regarded as a new variety of *H. dalei,* Milne-Edwards and Haime.

HALLOPORA *cf.* SUBPLANA (*Ulrich*)

Plate III, Figures 12 and 13; Plate IV, Figures 9, 13 and 14;
Plate V, Figure 4; Plate VI, Figure 9.

CALLOPORA SUBPLANA, *Ulrich.* Jour. Cin. Soc. Nat. Hist., 5, 1882, p. 253, pl. 11, figs. 7, 7b.
CALLOPORA SUBPLANA, *J. F. James.* Jour. Cin. Soc. Nat. Hist., 16, 1894, p. 196.
CALLOPORA SUBPLANA, *Cumings* 32nd Ann. Rep. Dept. Geol. Nat. Res. Indiana, 1908, p. 795, pl. 10, figs. 4, 4a; pl. 27, fig. 15.
HALLOPORA SUBPLANA, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 583.

Ulrich's description is as follows:

> Zoarium ramose, the branches cylindrical, from .2 inch to .5 inch in diameter, and divided dichotomously at intervals varying from .6 inch to 1 inch. Cells polygonal in unworn examples, subpolygonal or rounded in worn specimens. The surface exhibits clusters of from four to eight cells, that occasionally are slightly elevated above the general surface, and are conspicuously larger than the ordinary cells which surround them. The latter vary in diameter from one-seventieth to one-sixtieth of an inch (*i.e.* six to seven cells may be counted in the space of .1 inch), while those composing the clusters may attain a diameter of one-fortieth of an inch, though their usual diameter is only about one fiftieth of an inch. The interstitial cells are comparatively few, being most numerous and noticeable between the large cells of the clusters mentioned. Over the other portion of the surface they usually occur at the angles of junction of the ordinary large tubes. They are, however, always inconspicuous, and easily overlooked.
>
> In longitudinal sections the tubes in the axial region of the zoarium have very thin, flexuous, and often crimped walls. Diaphragms are usually not developed here, except a few (6 to 9) in the young tubes just above the point of their origin. These are placed at distances apart equalling about two of their diameters at the point of crossing. As the tubes bend outward to reach the surface their walls are thickened, the interstitial tubes make their appearance, and numerous diaphragms are developed in the large tubes, the latter often inosculate, while the distance between them usually varies from one-fourth to one-half of the diameter of the tube crossed. The diaphragms in the interstitial tubes are always complete and equally crowded in all.
>
> Tangential sections show that the tubes just below the surface have much thickened walls, their visceral chambers being rounded or oval. The walls of adjoining tubes are seemingly fused together, so that the original boundary line cannot be detected. The cavity of each tube is surrounded by a secondary deposit of dark, concentrically laminated sclerenchyma, while the original wall is represented by apparently structureless (in this section) sclerenchyma, of much lighter shade. The interstitial cells are variable in size and shape, and comparatively much reduced in numbers, being, as a rule, less numerous than the proper tubes.
>
> The characters which distinguish *Hallopora subplana* from all other species of the genus known to me from the Cincinnati group, are found in its robust growth, the large size of the cells, the conspicuous clusters, and the proportional paucity of the interstitial tubes.

Robust, comparatively smooth, dichotomously branching bryozoans are of common occurrence in the quarry at the brickyard in the Don Valley. Hitherto we have been in the habit of ascribing these to *Dekayella ulrichi* which they very closely resemble superficially. In some hundreds of sections, however, no trace of acanthopores has been found which makes it impossible to include them in that species. The resemblance of most of these forms to *Hallopora subplana* is so great that little doubt remains as to their identity with that species. There are, however, some slight differences which must be enumerated. First, the cells are somewhat smaller: in the type they are less than three to the millimetre, while in our specimens they number at least four in that space. The clusters of larger cells are less conspicuous and somewhat nearer together than in the type: in some cases they can scarcely be made out, while in others they are observable to the naked eye as slight rounded monticules. The cells of the clusters, in the type occur to the number of two or a little less in the millimetre while in our specimens an average of three occur in that distance. The internal structure as revealed by sections conforms very closely to that of the type. Some of the larger specimens show a strong resemblance to *Hallopora onealli communis*, James, and as that species has been recorded from this locality its occurrence must be regarded as probable although we are unable to definitely state that we have observed it.

The general shape of the zoarium of average specimens is shown in Plate VI, Figure 9. Surfaces are nearly always clogged with shale or encrusted with pyrite making the taking of photographs very unsatisfactory: Plate V, Figure 4 was prepared from a slightly worn specimen.

Figure 14 of Plate IV is a tangential section very close to the surface: it shows well the clusters of larger cells, the scattered mesopores and the character of the cell-wall. Figure 13 of Plate III was drawn to show the size of the cells and mesopores without any attempt to represent the character of the tissue. Figure 13, Plate IV is a photograph and Figure 12, Plate III a drawing from the same vertical section. Figure 9, Plate IV is a photograph of a segment of a transverse section across a branch.

Locality.—Don Valley brickyard, Toronto.

Nos. 1097 H.R., 1098 H.R., 1099 H.R., 1100 H.R. Royal Ontario Museum of Paleontology.

HALLOPORA DALEI *var.* SUBALTA, *var. nov.*

Plate III, Figures 9 and 11; Plate IV, Figures 8, 10, 11, 12; Plate V, Figure 2, Plate VI, Figures 5 and 6.

CHAETETES DALII, *Milne-Edwards and Haime.* Pol. Foss. Terr. Pal., 1851, p. 266, pl. 19, figs. 6, 6a.

MONTICULIPORA DALII, *Milne-Edwards and Haime.* Brit. Foss. Corals, 1854, p. 265.

CHAETETES APPROXIMATUS, *Nicholson.* Pal. Ohio. 2, 1875, p. 193, pl. 21, figs. 3, 3a.

MONTICULIPORA RAMOSA *var* DALEI, *Nicholson.* Genus Monticulipora, 1881, p. 115, fig. 19, C, D, pl. 2, fig. 4.

CALLOPORA DALEI, *Ulrich.* Jour. Cincinnati Soc. Nat. Hist., 5, 1882, p. 252.

CALLOPORA DALEI, *Cumings.* 32nd Ann. Rep. Dept. Geol. Nat. Res. Indiana, 1908, p. 792, pl. 8, fig. 11; pl. 27, fig. 12.

HALLOPORA DALEI, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 579 (See for more complete synonymy).

Milne-Edwards and Haime's description (*op. cit.*) is as follows:

> POLYPIER DENDROIDE, à rameaux cylindriques, larges de 6 à 8 millimètres présentant à leur surface de petits mamelons coniques saillants distants de 2 ou 3 fois leur diamètre. Calices à bords un peu épais, subégaux, subcirculaires, n'ayant, qu'un tiers ou même un quart de millimètre.

This species was redescribed by Nicholson in his work on the Genus Monticulipora as a variety of *Callopora ramosa* as follows:

> Not having had the opportunity of examining the original specimens upon which Milne-Edwards and Haime founded their *Chaetetes Dalii*, I cannot be absolutely certain that I have correctly identified it. Judging, however, from their figures and descriptions, I have little doubt that the form which I described as *Chaetetes approximatus* (Quart. Jour. Geol. Soc., vol. 30, p. 502, pl. 29, figs. 3, 3a, 1874) is really the same. Accepting his conclusion, the differences and resemblances between *Monticulipora ramosa*, D'Orb., and *M.Dalii*, E. and H., may be briefly stated as follows: As regards external characters, *M. Dalii* precisely agrees with the type form of *M. ramosa*, D'Orb., except that the monticules are much reduced in size, and that the interstital tubuli are sometimes not quite so conspicuous or numerous. The monticules are no longer boldly prominent or conical, but are much smaller, and in general either gently rounded or somewhat elongated transversely. With the above slight external difference, there is associated a complete agreement in internal structure, both tangential and longitudinal sections showing features precisely similar to those exhibited by corresponding sections of typical examples of *M. ramosa*, D'Orb. I cannot doubt, therefore, that as in the case of the so-called *M. rugosa*, E. and H., we have to deal in *M. Dalii*, E. and H., with nothing more than a well marked variety of *M. ramosa*, D' Orb.

Cumings (*op. cit.*) while retaining *Callopora dalei* as a distinct species adopts Nicholson's view as follows:

> In internal characters there is no particular difference between this form and *C. ramosa*. Externally it differs only in the small size of the monticules, and even in this particular it is an easy matter to find transitional forms between *C. dalei* and *C. ramosa*.

The description given by Nicholson for *Chaetetes approximatus* which is regarded as identical with *Hallopora dalei* is as follows:

> Corallum composed of cylindrical stems, from one and a half to nearly three lines in diameter, dividing dichotomously at short intervals. Corallites tolerably thick-walled, oval, sub-circular, or polygonal in shape, some eight to ten in the space of one line, often with excessively minute corallites interspersed amongst them, though these are rarely as abundant as in the preceding forms (*Chaetetes dalei* and *Chaetetes rugosus*), and may be nearly absent. Surface exhibiting a number of small conical or somewhat transversely elongated eminences, which are very slightly elevated above the general surface. These eminences are placed in irregular diagonal rows, separate about half a line transversely and two-thirds of a line measured vertically, and they are either solid at their summits, or carry a few excessively small cylindrical tublii, with or without one or more of the ordinary corallites.

Among the commonest fossils in the exposures on the Don river is a ramose monticulose bryozoan very closely allied to if not identical with *Hallopora dalei*. It occurs in association with *Hallopora subplana* and might be mistaken for examples of that species in which the monticules are unusually well developed. It can always be distinguished, however, by the smaller size of the apertures and the greater number of mesopores. Externally and internally this form approaches very close to *Hallopora dalei* but it differs in the degree of development of the monticules in so constant a manner that we feel justified in considering it as a distinct variety. When compared with typical examples of *H. dalei* from the Cincinnati district it is found in every instance that the monticules are lower and less pointed than in that species. In fact, the development in this respect is intermediate between that of typical *H. dalei* and that of *H. andrewsi*. In this latter species a stellate arrangement of the larger cells is a distinguishing feature: such arrangement, but much less pronounced, is also to be observed in our variety. This feature is not characteristic of *H. dalei*. For two reasons, therefore, our variety is intermediate between typical *H. dalei* and *H. andrewsi*, but it is impossible to ascribe it to the latter species on account of the large number of mesopores.

The general appearance of typical fragments is shown in Plate VI, Figure 6; the surface highly magnified is shown in Figure 5 of this plate and also by photographic reproduction in Plate V, Figure 2. The tangential section, Plate IV, Figure 8, shows the smaller size of the zooecial apertures and the greater number of mesopores as compared with Figure 14 of *H. subplana*. The margins of this figure show the tubes cut diagonally as the section passes into the monticules. Figure 10 of this plate shows a shallow tangential section highly magnified to illustrate the character of the tissue. Vertical and transverse sections are shown in Figures 11 and 12. Figure 9 of Plate III was drawn to show the size and arrangement of the cells without reference to the character of the tissue. Figure 11 is a drawing from the same section as Plate IV, Figure 12.

Locality.—Don Valley brickyard, Toronto.
No. 1101 H.R. Royal Ontario Museum of Paleontology.

HALLOPORA O'NEALLI, *var.* (*James*)

CHAETETES? O'NEALLI, *James*. Introd. Catal. Low. Sil. Foss., 1875, p. 2.
MONTICULIPORA O'NEALLI, *James and James*. Jour. Cin. Soc. Nat. Hist., 10, 1888, p. 174; *J. F. James*. Ibid., 16, 1894, p. 194.
CALLOPORA O'NEALLI, *Miller*. N. A. Geol. Pal., 1889, p. 296.
CALLOPORA O'NEALLI, *Bassler*. Proc. U. S. Nat. Mus., 30, 1906, p. 23, pl. 6, figs. 1, 2.
CALLOPORA O'NEALLI, *Cumings*. 32nd. Ann. Rep. Dept. Geol. Nat. Res. Indiana, 1908, p. 786, pl. 9, figs. 3, 3b; pl. 27, figs. 9, 10.

This rather variable species was originally defined by James as follows:

> Corallum dendroid; slender cylindrical branches, dividing, generally dichotomously at irregular distances, and in some cases anastomosing; branches from half a line to two lines in diameter. Calices generally oval, but is some cases the variation may be from subcircular to polygonal, and from eight to ten in the space of a line, measuring lengthwise of the stem, varying considerably in size, occasionally one much larger than the average. Walls of corallites rather thick; minute tubes often between the apertures. The increase of corallites seems to be by fission. A cut section shows the stronger corallites as starting at the centre, growing parallel with the length of the stem and following the direction and dividing with the branches, the outer ones curving to the surface obliquely, although the apertures appear to be direct.

From the above description it would appear that *H. onealli* is a ramose type of the genus with branches of small diameter but apparently up to 4 mm., without maculae, monticules or clusters of larger cells, with numerous mesopores and with many diaphragms in both zooecial tubes and mesopores. The most characteristic features are the relatively short length of the zooecial tubes in the thickened mature region and the considerable slope at which they approach the surface.

Several varieties of *H. onealli* have been described: these are based to some extent on mere difference of size but in certain cases on more reliable features.

The rocks at Toronto, both on the Humber and on the Don, show many examples of a branching bryozoa, coarser than *Bythopora arctipora*, and finer than *Hallopora subplana* but varying considerably in diameter, and in the manner of bifurcation. These forms we have ascribed to *Hallopora onealli* after submitting typical sections to Dr. Ray S. Bassler of the United States National Museum. Dr. Bassler makes the following comment on the sections. "*Hallopora onealli* and its varieties are so abundant that the species as now understood has rather wide limits. Your slides indicate one of the varieties with smaller zooecia than the typical form."

Locality.—Cliff on west side of Humber river at Weston.
No. 1192 H. R. Royal Ontario Museum of Paleontology.

Sub-order CRYPTOSTOMATA

Family PTILODICTYONIDAE.

Genus ARTHROPORA, *Ulrich*

ARTHROPORA, *Ulrich*. Jour. Cincinnati Soc. Nat. Hist., 5, 1882, p. 152.

The original description of this genus is as follows:

> Zoarium jointed, segments short, with several branches or spurs projecting from each edge. Cell apertures sub-circular, separated by interstitial pits or sulci, and occasionally closed by an operculum.

ARTHROPORA SHAFFERI (*Meek*)

Plate II, Figure 11; Plate V, Figure 5.

PTILODICTYA (STICTOPORA) SHAFFERI, *Meek*. Proc. Acad. Nat. Sci. Philadelphia, 1872, p. 317; Pal. Ohio, 1, 1873, p. 69, pl. 5, figs 1a-c.
PTILODICTYA SHAFFERI, *Nicholson*. Pal. Prov. Ont., 1875, p. 33, fig. 4.
STICTOPORA SHAFFERI, *Lesley*. Geol. Surv. Pennsylvania, Rep. P4. 1890, p. 1069.
ARTHROPORA SHAFFERI, *Ulrich*, Jour. Cincinnati Soc. Nat. Hist., 5, 1882, p. 167, pl. 7. figs. 10-10a.
ARTHROPORA SHAFFERI, *Bassler*. U. S. Nat. Mus., Bull. 92, 1915, p. 72. (See for full synonymy).

Meek's description of this species follows:

Polyzoum small and delicate, consisting of slender compressed divisions that give off on each side, rather closely arranged, regularly alternating, lateral branches of the same breadth as the main stem, from which they diverge at an angle of about 40°; lateral branches, in the same way, giving off on each side, very short, lobe-like, alternating projections; flattened lateral margins of all parts very narrow, sharp and minutely striated longitudinally, in well-preserved specimens; pores apparently without raised margins, more or less oval longitudinally, alternately disposed in longitudinal and oblique rows, so as to present a quincuncial arrangement; the number of longitudinal rows varying from five to about seven in the breadth of a stem or branch; spaces between the pores measuring transversely to the stems and their divisions about equal to the breadth of the pores, but greater, measuring in the direction of the oblique and longitudinal rows all ornamented, in perfectly preserved specimens, by very minute, more or less waved or flexuous striae.

Size of entire polyzoum unknown; breadth of stems and branches, 0.05 inch; number of pores in 0.05 inch, measuring in the direction of the oblique rows about 4 or 6, and in the same space measuring longitudinally from 3 to 4.

This very delicate little species will be readily distinguished from the other known Silurian (Ordovician) forms by its small size and its peculiar plumose mode of growth; and particularly by its very minute striae between the pores.

Concerning this species, Ulrich (*op. cit.*) makes the following remarks:

Meek's description of this species is in the main correct, but he did not notice that the zoarium is a jointed one. I have in my cabinet a specimen which preserves no less than forty of the segments in connection.

Nothing need be added to the above descriptions. The occurrence of this species on the Credit river was recorded by Nicholson, and Foerste mentions it in his list of fossils from the Don valley. The species is rather rare in this locality.

Locality.—Don Valley brickyard.

No. 1102 H.R. Royal Ontario Museum of Paleontology.

Sub-order CHEILOSTOMATA

Genus Paleschara, *Hall*

Paleschara, *Hall*. 26th Ann. Rep. New York State Mus., 1874, p. 107.
Paleschara, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 941. (See for synonomy.)

Hall describes the genus as follows:

Bryozoum parasitic, or free, forming incrustations upon the surfaces of other fossils, or in independent frondose expansions. Surface with polygonal cellules, separated by thin solid walls; without evidence of rays or transverse septa.

Ulrich (Cincinnati Soc. Nat. Hist., 5, p. 157) adds the following:

Zoarium incrusting; tubes very short. Cell-apertures direct, angular, and more or less oblong.

Paleschara beani (*James*)

Plate III, Figures 10, 10a; Plate V, Figure 7.

Ceramopora (?) beani, *James*. Paleontologist, No. 1, 1878, p. 5; Jour. Cincinnati, Soc. Nat. Hist., 7, 1884, p. 23, figs. 3-3b.
Paleschara beani, *Ulrich*. Amer. Geol., 1, 1888, p. 186.
Paleschara beani, *Bassler*. Proc. U.S. Nat. Mus., 30, 1906, p. 46.
Paleschara beani, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 942.

James describes the species as follows:

Polyzary forming thin, irregular expansions, parastic upon the surface of *Orthoceras*, and probably other foreign substances. Sometimes in colonies, in other cases completely covering the body of sections of *Orthoceras*. The cells have, sometimes, eccentric points from which they radiate, and are arranged in a somewhat quincuncial order in alternating oblique rows; but in other cases they are not so regularly disposed. Cell-walls rather thick and not raised above the general surface; apertures slightly oblique in some cases. Cell-apertures generally long oval or diamond-shaped, but sometimes quite irregular in form. The best specimens show, occasionally, minute pores at the angles or junctions of some of the cell-walls. About three cells in the space of a line measuring the longer diameter, and four or five measuring transversely, except at the radiating points, where they are smaller. In some examples the cells and cell-walls resemble the non-poriferous face of the fenestrules and branches of ***Retipora***, but much smaller than any specimens noticed of that genus.

This species occurs, but infrequently, in the rocks of the Don Valley brickyard. The specimen used for illustration covers the surface of a fragment of *Orthoceras* 25 mm. wide by about 40 mm. long.

Locality.—Don Valley brickyard, Toronto.
No. 1103 H.R. Royal Ontario Museum of Paleontology.

Conclusion

All the forms of *Bryozoa* which we have been able to recognize in our rather extensive collections are described above but it is very likely that many species have been overlooked. This is in part due to insufficient material and in part to the fact that specimens from the shale seldom present surfaces sufficiently well preserved to justify identification: it is not until sections are prepared that a degree of certainty is arrived at; this is particularly true of the various species of *Stigmatella.*

As other species have been recorded from Toronto rocks it is necessary to include here a short revision of previous publications on the subject.

Report upon the Paleontology of the Province of Ontario—by Henry Alleyne Nicholson

Besides certain of the species already described, Nicholson refers to the following:

Chaetetes fletcheri, Nicholson—Synonym for *Dekayella ulrichi,* Nicholson. As already stated, we are of the opinion that most, if not all, of the specimens referred to this species are really *Hallopora subplana.*

Chaetetes petropolitanus, Pander—Considered as a synonym of *Mesotrypa whiteavesi,* Nicholson. This is a Trenton species and is unlikely to occur at Toronto and Weston as stated by Nicholson. We are of the opinion that Nicholson had in hand some of the forms which we have ascribed to *Stigmatella.*

Chaetetes discoideus, James—Synonym for *Amplexopora discoidea.* Nicholson states that this form is not uncommon at Weston and our older collections contain specimens so labelled. While we would hesitate to deny the occurrence of the species we have found that those discoidal bryozoans which we have sectioned do not belong to the genus *Amplexopora.*

Chaetetes undulatus hemisphericus, James—Synonym for *Monotrypa undulata hemispherica.* The genus *Monotrypa* has no acanthopores and Nicholson makes no mention of these structures in his description of the "puff-ball" fossils. All our sections of these variable bryozoans show more or less development of acanthopores on which account we have removed them to *Stigmatella.* It is possible that *Stigmatella crenulata* is identical with or allied to *Monotrypa undulata hemispherica.*

Upper Ordovician Formations of Ontario and Quebec—by A. F. Foerste

Most of the *Bryozoa* mentioned by Foerste have been identified in our collections and described above. The only forms requiring comment are as follows:

Spatiopora maculosa, Ulrich—Recorded from the Don brickyard. This is probably the same species which we have described as *S. varians.*

Hallopora communis, James—Synonym for *Hallopora onealli communis.* Identified by Ulrich and recorded by Foerste as occurring in the Don Valley quarry. We have been unable to indentify this form with certainty from the material in our collections. In view of the eminent authority for its occurrence the species must be listed among the fossils from the Don valley.

Twelfth International Geological Congress, Guide Book 6.

The list here given was compiled from specimens in the collections of the Royal Ontario Museum. A critical examination of this material compels the following corrections.

HETEROTRYPA FRONDOSA, *D'Orbigny.* Mistaken identification for PERONOPORA VERA.
HETEROTRYPA INFLECTA, *Ulrich.* Not recognized.
HEMIPHRAGMA WHITEFIELD, *James.* Not recognized.
LEPTOTRYPA IRREGULARIS, *Ulrich.* Probably LEPTOTRYPA EXPANSA.

BRACHIOPODA

A description of the different species follows:

Order ATREMATA

Family LINGULIDAE

Genus LINGULA, *Bruguière*

LINGULA, *Bruguière.* Encyclopédie Méthodique, 1, 1792, pl. 250.
LINGULA, *Hall and Clarke.* Pal. New York, 8 pt. 1, 1892, pp. 2, 161
LINGUDA, *Bassler,* U. S. Nat. Bull. 92, 1915, p. 724. (See for complete synonymy).

The description of the genus *Lingula* according to Hall and Clarke follows:

> Shells sub-equivalve, equilateral; elongate-ovate, subquadrate or subtriangular in outline; broad over the pallial region, cardinal slope more or less conspicuous; slightly gaping at both extremities. Brachial or dorsal valve somewhat the shorter, and with a slightly thickened hinge line. Surface of the shell smooth, or concentrically and radiately straited. Animal attached by a long, muscular pedicle protruding from between the beaks of the two valves.

LINGULA WESTONENSIS, *sp. nov.*

Plate VII, Figure 1.

A species of *Lingula* which we have been unable to ascribe to any described form occurs occasionally on the Humber river. While this species resembles somewhat *Lingula obtusa,* Hall, it seems to differ sufficiently to justify the creation of a new species.

The outline of the shell is distinctly ovate with the maximum diameter about one-third of the length from the anterior margin. The concentric markings conform with the outer margin: they are fairly sharp laterally but posteriorly and medially they are less numerous and less defined and more of the nature of undulations. Posteriorly there is evidence of a slight median scar. As already stated this form resembles *Lingua obtusa,* Hall, but differs in being slightly more elongate. From *L. progne,* Billings, it can be distinguished by the less quadrangular form and the fainter median scar.

Length of type 12 mm., width 8 mm.

Locality.—West side of Humber river below bridge at Weston, Ontario.
No. 1079 H.R. Royal Ontario Museum of Paleontology.

LINGULA *cf.* PROGNE, *Billings*

Plate VII, Figure 2.

LINGULA PROGNE, *Billings*. Pal. Fossils, 1, Geol. Sur. Canada, 1865, p. 47, fig. 50.
LINGULA PROGNE, *Billings*. Geol. Canada, 1863, p. 151, fig. 134; p. 201, fig 196.
LINGULA PROGNE, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 732.

The commonest species of *Lingula* found at Toronto resembles very closely the figures given by Billings for *L. progne* the description of which follows:

> Shell oblong-oval; both valves gently and uniformly convex; front margin broad and rounded or somewhat straight; anterior angles rounded; sides and the anterior two-thirds of the length with the exception of the anterior angles straight or gently convex, parallel; in the posterior third converging with a slightly convex slope to the beak. The ventral valve is somewhat pointed at the beak with an apical angle of about 70 degrees; the apex of the dorsal valve is obtusely rounded. Surface with concentric undulations, more numerous in some specimens than in others. In addition to these there are fine concentric striae and longitudinal radiating lines, the latter not visible at shining.

In the above description Billings makes no mention of the presence of a pronounced median scar but all his figures show this feature and it has been customary to make use of this peculiarity in identifying specimens of the species from the Collingwood and Utica formations. The presence of this scar is probably due to a pronounced median septum.

On the basis of the description alone one would have no difficulty in ascribing our forms to *L. progne*, but, although numerous specimens are available, only the slightest trace of a median scar is to be seen.

The figure of the brachial valve has been drawn from a Toronto specimen but the median scar has been added in accord with Billing's figure. The pedicle valve is considerably more pointed and specimens are frequently found showing its beak and the tract of the peduncle extending beyond the apex of the brachial valve.

Locality.—Don brickyard, Toronto.

No. 1104 H.R. Royal Ontario Museum of Paleontology.

Sub-genus PSEUDOLINGULA, *Mickwitz*

LINGULA (PSEUDOLINGULA) RECTILATERALIS, *Emmons*

Plate VII, Figure 3.

LINGULA RECTILATERALIS, *Emmons*. Geol. New York, Rep. 2nd Dist., 1842, p. 399 fig. 6.
LINGULA RECTILATERALIS, *Foerste*. Bull. Sci. Lab. Denison University, 17, 1914, p. 254.
LINGULA QUADRATA, *Hall*. Pal. New York, 1, 1847, p. 96, pl. 30, fig. 4; p. 285 pl. 79, fig. 1.
LINGULA RECTILATERALIS, *Ruedemann*. New York State Mus. Bull., 162, 1912, p. 91, pl. 4, fig. 1.

Hall's description of this species is as follows:

> Equivalve, equilateral, broadly oval, depressed-convex; sides nearly straight and parallel, or slightly curved; extremities nearly equal in width, the first broadly rounded cardinal extremities slightly narrower and somewhat angularly sloped; beak marginal, not prominent; exterior surface of the shell marked by strong concentric striations, and along the middle by distinct longitudinal striae, which are equally visible when the outer shell is exfoliated. A longitudinal depressed line marks the shell from the beak nearly half way to the base.
>
> This species is perhaps the largest fossil *Lingula* known: it is distinguished by its general elliptical form and nearly parallel sides. In its dimensions it is near the *Lingula lewisii*, Sowerby; but is more regularly rounded at the base, and does not preserve the square outline which that shell has. Our largest specimen is one inch and a half in length, with a width of almost an inch.

The usual length of this shell is one inch, and its great size alone is commonly sufficient to distinguish it from any other species in our strata. The longitudinal striae mark only the central part of the shell, and are equally distinct when the shell is exfoliated: this character may be useful in detecting this species.

Our collections contain only two specimens from the Don valley which we venture to ascribe to this species. In general shape they approach very closely to Hall's description and figures but there is no trace of the longitudinal striations on which he lays stress, and the size is considerably less. The figure given by Ruedemann, however, is without longitudinal striations and is indistinguishable from our specimens. Length, 15.8 mm.; width anterior, 10.7 mm.; width posterior, 9.3 mm.

Locality.—Don brickyard, Toronto.

No. 1105 H.R. Royal Ontario Museum of Paleontology.

Order NEOTREMATA

Family TREMATIDAE

Genus Schizocrania, *Hall and Whitfield*

Schizocrania, *Hall and Whitfield*. Pal. Ohio, 2, 1875, p. 71.

Schizocrania, *Hall and Clarke*. Pal. New York, 8, pt. 1, 1892, pp. 142, 168.

Schizocrania, *Cumings*. 32nd Ann. Rep. Dept. Geol. and Nat. Res. Indiana, 1907, p. 894

The description given by Hall and Whitfield follows:

> Among the unarticulated brachiopods of the Silurian formation there is a group of radiatingly striated shells, which may be typified by *Orbicula? filosa*, Hall, Pal. New York, Vol. 1., p. 99, pl. XXX, fig. 9, which have usually been referred to the genera *Discina* and *Trematis*, but which do not exactly correspond in character to either of those genera. They differ from *Discina*, and also from *Orbiculoidea* in several particulars; among which may be mentioned the striated surface, the marginal beak of the upper valve, and the widely divided posterior margin of the lower valve, which forms a deep marginal notch, instead of an eccentric foramen or perforation, as in those genera. The lower valve in this group is firmly fixed and cemented to foreign substances, while those of the above genera are free, the whole being attached only by a byssus passing through the foramen of the lower valve. The substance of the shell is also of a much more calcareous nature, if not entirely so. The features as at present known are given in the following diagnosis: Unarticulated, inequivalve, brachipodous shells, growing parasitic on foreign bodies, to which they are attached by the close adhesion and anchylosis of the external or inferior surface of the lower valve. Lower valve flat or conforming to the surface to which it adheres; deeply notched on the posterior side of the centre, the notch extending from a point more or less distant from the centre of the valve to the posterior margin, where the sides of the slit are widely and distantly separated. Upper or free valve more or less convex, and having a beak terminal on the posterior margin. Surface of the upper valve radiatingly striated in the typical species; the lower valve concentrically wrinkled. Muscular imprints of the free valve, six known: two of which are situated near the rostral portion of the valve, large, ovate, and diverging; two minute, approximate just below and between the former; and two of medium size, circular, distant from each other, and situated near the centre of the valve. Those of the lower valve unknown. The striated surface, widely notched lower valve, and parasitic habits are the strong distinctive points.

Schizocrania filosa (*Hall*)

Plate VII, Figures 4 and 5.

Orbicula ? filosa, *Hall*. Pal. New York, 1, 1847, p. 99, pl. 30, fig. 9.

Orbiculoidea filosa., *Emmons*. Amer. Geol., 1, pt. 2, 1855, p. 200. pl. 8, fig. 9.

Crania filosa, *Hitchcock*. Geol. Vermont, 1, 1862, p. 292, fig. 196.

Obolus filosus, *Safford*. Geol. Tennessee, 1869, p. 276, fig. 9.

TREMATIS FILOSA, *Billings*. Geol. Canada, 1863, p. 159. fig. 126.
SCHIZOCRANIA FILOSA, *Hall and Whitfield*. Pal. Ohio. 2, 1875, p. 73, pl. 1. figs. 12-15.
SCHIZOCRANIA FILOSA, *Cumings*. 32nd Ann. Rep. Dept. Geol. Nat. Res. Indiana, 1908, p. 933, pl. 34, figs. 8 and 8a.
SCHIZOCRANIA FILOSA, *Foerste*. Bull. Sci. Lab. Denison, Univ., 16, 1910, p. 40.

The original description of this species is given below:

Shell orbicular, or very slightly ovate, the beak of the upper or free valve projecting a little beyond the limits of the circle, giving a somewhat greater diameter along the median line than in a transverse direction. Free valve moderately convex, the central region being the most prominent. Attached valve discoid, very thin, deeply and broadly notched on the posterior side; the notch not extending quite to the centre of the valve; occupying nearly one quarter of the circumference of the valve on the outer margin; border of the notch thickened, especially at the base, which is rounded, and the centre marked by a slightly projecting point. Interior of the free valve marked by two proportionally large, elongate ovate, diverging muscular prominences, leaving corresponding pits on the casts of the shell, or on exfoliated specimens; situated just below the beak, and extending for nearly or quite one fourth of the length of the valve from the apex. There are also two other muscular impressions somewhat smaller in size, circular in form, and situated near the middle of the valve below the extremities of the ovate imprints, and slightly more distant from each other. Beneath the beak there is a slight thickening of the cardinal border. The muscular markings of the lower valve have not been observed.

Surface of the shell of the convex valve marked by fine, even, threadlike, radiating striae; increased both by division and implantation, and gradually increasing in strength toward the border of the shell; the interspaces where the shell is perfectly preserved are flattened, the striae appearing as raised lines on the surface. The attached valve is strongly marked by irregular concentric undulations circling the valve parallel to the margin, but interrupted at the border of the notch.

This species is of somewhat rare occurrence in the shales of the Don valley. Fairly good examples of the brachial valve are contained in our collections but we have no material illustrating the pedicle or attached valve. Dimensions of form figured: length, 13.8 mm., width, 13.2 mm.

Locality.— Don Valley brickyard, Toronto.
No. 1106 H.R. Royal Ontario Museum of Paleontology.

Genus TREMATIS, *Sharpe*

TREMATIS, *Sharp*. Quart. Jour. Geol. Soc. London, 4, 1848, pp. 66, 68.
TREMATIS. *Hall and Clarke*. Pal. New York, 8, pt. 1, 1892, pp. 138, 168.
TREMATIS, *Cumings*. 32nd Ann. Rep. Dept. Geol. Nat. Res. Indiana, 1908, p. 895.

The description given by Hall and Clarke is as follows:

Shell subcircular or transversely oval in outline. Pedicle valve unevenly convex, more or less depressed over the posterior region; apex at, or behind, the centre; directly beneath it begins the pedicle fissure, which transects the shell, vertically widening to the posterior margin with straight or outwardly curving edges. Brachial valve evenly convex, with its apex marginal and slightly projecting. On the interior, the pedicle valve shows a faint median furrow extending from the angle of the fissure to the apex of the shell; this groove widens at its apical termination and may represent a point of muscular attachment. The sides of the fissure are often thickened by callosities similar to those sometimes seen in species of *Orbiculoidea*. From the apex of the valve extend radiating and branching vascular sinuses.

In the brachial valve the posterior margin is much thickened and broadly grooved to allow the extrusion of the pedicle. This thickening does not take the form of a cardinal area or shelf, but is rather a callosity closely appressed against the interior surface of the shell, the central portion being projected beyond the margin of the pedicle valve. Directly below and in front of this area are two transversely elongate scars, adjustors or posterior adductors, which are usually partly concealed by the progressive overgrowth of the cardinal thickenings. A faint median septum begins between these scars and passes forward, becoming more prominent over the tongue-shaped median elevation which separates the large central scars. These impressions are oblique and are not simple, each appearing to be composed of two, if not three distinct scars, making a posterior, a median and an anterior pair. What appears to be the posterior pair is small, and sometimes quite sharply defined, the central pair very much larger, and the anterior pair narrow, situated at either side of the angle of the median callosity and separated by its apex. The specialization of the first of these scars is not satisfactorily established; the entire impression is deeply excavated. In some well-preserved specimens, there is also evidence of external, marginal scars lying just in front of the outer ends of the posterior adductors.

Surface of both valves more or less completely covered by a beautiful ornamentation consisting of punctures or small pittings of varying depth, arranged either in a quincunx or in radiating rows; in the latter case they may be distant from one another without intervening ridges, or lie in radiating furrows, when they are either circular or sub-rectangular.

Shell substance composed of an outer calcareous layer with a series of inner corneous lamellae. The outer layer varies in thickness in different species and is coarsely punctated by the pittings constituting the surface ornamentation. The corneous layers are impunctate.

TREMATIS MILLEPUNCTATA, *Hall*

Plate VI, Figure 1; Plate VII, Figures 7 and 8.

TREMATIS MILLEPUNCTATA, *Hall*. Desc. New Species Crinoids and other Fossils, 1866, p. 14.

TREMATIS MILLEPUNCTATA, *Hall and Whitfield*. Pal. Ohio, 2, 1875, p. 70, pl, 1, figs. 4-7.

TREMATIS MILLEPUNCTATA, *Hall*. 24th Rep. New York State Cab. Nat. Hist., 1872, p. 221, pl. 17, figs. 22-25.

TREMATIS MILLEPUNCTATA, *Cumings*. 32nd Ann. Rep. Dept. Geol. Nat. Res. Indiana, p. 943, pl. 34, figs. 9-9a.

The original description of this species is quoted below:

> Shell small, suborbicular, transverse on the ventral side and lenticular in profile. Ventral valve strongly convex below the middle, more depressed above; with a narrow deeply depressed pedicle-opening, the margins of which are flattened for a space nearly equal to the breadth of the opening. Dorsal valve more elongate, most convex above the middle; the beak pointed and projecting considerably beyond the opposite valve; with a depressed or concave triangular area. Interior of the dorsal valve marked near the middle by two comparatively large semicircular or reniform muscular scars, the breadth across the two more than equal to one-third the diameter of the valve; the centre of the valve has also a slight mesial septum.
>
> Surface strongly punctate in concentric curves passing from the centre of the shell outwards, extending through the shell near the front of the valves, and distinctly marking the cast: inner layers of the shell not punctate.

Trematis millepunctata is fairly common in the shale beds at Toronto but perfect specimens are exceedingly rare. Very small fragments, however, suffice for its identification on account of the distinctive ornamentation. The figures are composite drawings founded on four different specimens.

Locality.—Don brickyards, Toronto.
No. 1107 H.R. Royal Ontario Museum of Paleontology.

TREMATIS OTTAWAENSIS, *Billings*

TREMATIS OTTAWAENSIS, *Billings*. Geol. Surv. Canada, Pal. Foss. 1, 1865, p. 53, fig. 58.

TREMATIS OTTAWAENSIS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 1280. (See for more complete synonymy.)

This species of *Trematis* is very clearly defined by the character of the ornamentation which is thus described by Billings:

> Surface with fine, radiating striæ, which increase by interstitial addition, sometimes closely crowded together, in which case there are ten or twelve in the width of a line; occasionally more distant, or from four to eight in one line. The intermediate grooves are divided into square compartments by cross ridges, which connect the radiating

ridges, but are not continuous, those in one groove not corresponding in position with those in the adjacent grooves, so as to form uninterrupted concentric lines. In specimens with the striae closely crowded together, only the radiating lines are distinctly visible, but the others can always be detected in good specimens, on close examination.

It is with some hesitation that this species is recorded from the rocks at Toronto. We have a single specimen, the indentification of which is reasonably certain, but the locality of occurrence is open to question. The specimen was found in the old collections, labelled "*Trematis millepunctata*, Humbervale quarry, Toronto, collected by J. Townsend." In view of the fact that not another trace of the species has been found, and admitting the possibility of a misplaced label, it seems advisable not to definitely record the occurrence of the species.

Locality.—Humbervale quarry, Toronto.
No. 1162, R. H. Royal Ontario Museum of Paleontology.

Family CRANIIDAE

Genus PHOLIDOPS, *Hall*

PHOLIDOPS, *Hall.* Pal. New York, 3, 1859, p. 489.
PHOLIDOPS, *Hall and Clarke.* Pal. New York, 8, pt. 1, 1892, p. 155.
CRANIOPS, *Hall.* 12th Rep. New York State Cab. Nat. Hist., 1859, p. 84.
PHOLIDOPS, *Schuchert.* Zittel-Eastman Text Book of Pal., p. 379.

The description as given by Hall and Clarke follows:

Shells small, patelliform, equivalve, equiconvex, inarticulate, unattached. Outline oval or subelliptical; apex subcentral, excentric or marginal, sometimes terminal and produced. Surface marked by strong, concentric, often lamellose lines of growth, which are crowded on the posterior, and distant on the anterior portions of the valves; these are sometimes crossed by faint interrupted radiating lines. In the interior the surfaces of contact make a broad smooth, flat or slightly convex border, somewhat broader in front than behind. The muscular and visceral area occupies a sharply defined and very limited space in the apical portion of each valve. In both valves it is essentially of the same size and subtriangular in outline, the apex of the triangle pointing forward and usually surrounded by a conspicuous callosity.

The ventral (?) valve bears two well-defined central adductors occupying the same relative position as in *Crania;* these impressions are usually simple, but appear to be sometimes complicated by association with ill-defined scars of the anterior muscles. The posterior adductors or divaricators are situated at the basal angles of the muscular triangle, and are distant from the posterior margin. The linear parietal scars are very strong, the posterior being more or less distinctly lobate, the anterior generally straight or rounding about the central adductors. In the opposite or dorsal (?) valve the scars have essentially the same arrangement; the anterior adductors, however, are separated by elongate median scars (anteriors) which traverse the elevated callosity surrounding the anterior margin of the area. The posterior scars are often more widely divergent than in the other valve. Shell substance calcareous and impunctate (?).

PHOLIDOPS CINCINNATIENSIS, *Hall*

Plate VII, Figure 6.

PHOLIDOPS CINCINNATIENSIS, *Hall.* 24th Rep. New York State Cab. Nat. Hist., 1872, pl. 7, fig. 10.
PHOLIDOPS CINCINNATIENSIS, *Meek.* Pal. Ohio, 1, 1873, p. 130, pl. 5, fip. 2.
PHOLIDOPS CINCINNATIENSIS, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 968, (See for complete synonymy).

Meek's description of the species is as follows:

Shell small, ovate in outline. Larger valve about one-fifth longer than wide, with height one-third to one-fourth the breadth. Apex obtuse, near half way between the middle and the larger end. Anterior end narrowly rounded, posterior end somewhat more broadly rounded, or almost subtruncate. Surface ornamented by six or seven sub-imbricating marks of growth. Smaller valve unknown.

This species is fairly common at all the collecting localities near Toronto; only the larger valve is found. In our collections many of these shells have been labelled *Pholidops subtruncata* with which the present species is closely related. In our opinion, however, all the shells are to be referred to *P. cincinnatiensis.* Dimensions of form figured: length 5.7 mm., width 4.6 mm.

Locality.— Don brickyards; Humber river, Toronto.
No. 1108 H.R. Royal Ontario Museum of Paleontology.

Family ORTHIDAE

Genus DALMANELLA, *Hall and Clarke.*

DALMANELLA, *Hall and Clarke.* Pal. New York, 8, pt. 1, 1892, pp. 205, 223.

The description of the genus is as follows:

> Shells plano-convex or subequally biconvex. Pedicle valve usually the deeper, often gibbous, elevated at the umbo and arched over the cardinal area. Hinge line generally shorter than the greatest width of the shell. In many of the species there is a more or less conspicuous, undefined median fold and sinus on the pedicle and brachial valves respectively. Surface covered with fine, rounded bifurcating striae.
>
> In the pedicle valve the teeth are quite prominent, thickened at their extremities and supported by lamellae which are produced forward circumscribing a rather short suboval or subquadrate muscular area, which is more or less distinctly defined in different species and in different conditions of the shell. In *Orthis meeki*, Miller, a somewhat ponderous, biconvex, multistriate variation of *Orthis testudinaria*, it is clearly resolvable into adductor and diductor scars, the latter bounding, but not altogether enclosing, the impression of the adductors; the pedicle-scar is also discernable. In the brachial valve the cardinal process extends forward as a ridge to the bases of the crural plates, where it is broadened and continued thence as a median ridge separating the muscular impressions. The inner surface of this process is divided by a faint median furrow which produces two lobes at the posterior extremity, and each of these lobes is again divided making the process quadrilobate. Sometimes the inner division of the two main lobes have coalesced, producing a strong median lobe and thus making the process appear trilobate. In some species at maturity, and in others from abnormal growth this process becomes a broad plug, which fills the entire delthyrial opening. The dental sockets are small, the crural plates often greatly elevated, especially in the plano-convex forms, and they are not usually produced into a ridge about the muscular area, but end abruptly. Muscular impressions quadruplicate, sometimes with radiating ridges extending from the lateral and anterior margins.

DALMANELLA RUGOSTRIATA, *sp. nov.*

Plate VII, Figures 9 and 10.

In our collections there is only one species referable to the genus *Dalmanella;* this has commonly been regarded as *Dalmanella testudinaria* or a variety of that variable species. We are now convinced that it differs sufficiently from any known form to justify the creation of a new species.

The shell is known chiefly by a number of flattened pedicle valves preserved in shale. The generic reference and specific characteristics are founded, therefore, on the external features of this valve only. The shell is transversely oval being somewhat wider than long and thus differing in outline from *D. testudinaria.* The cardinal angles are rounded and the posterior margin shows a slight concavity between the angle and the rather prominent beak. The surface presents about seventy-five radiating striae of which possibly ten actually reach the beak. These striae are rather irregular and arise partly by bifurcation and partly by intercalation. On the lateral slopes the striae arise with fair uniformity as follows: two main striae bifurcate and between the pairs thus produced a single stria is intercalated which is more closely associated with the posterior than with the anterior neighbouring stria. In consequence of this arrangement the striae appear roughly in groups of three.

A characteristic feature of the ornamentation is the presence in the depressions between the striae of delicate transverse markings very suggestive of those observed in *Dinorthis carleyi* (*Plaesiomys retrorsa*).

The average measurements of the co-types are: length 15 mm., width 21 mm. The largest shell from which the outline of the figure was drawn measures 22 by 17 mm.

Locality.—Don brickyards, Toronto.
No. 1078 H.R. Royal Ontario Museum of Paleontology.

Family STROPHOMENIDAE

Genus Leptaena, *Dalman*

Leptaena, *Dalman.* Kongl. Svenska. -Akad. Handl., for 1827, 1828. pp. 93, 94.

Leptaena, *Hall and Clarke.* Pal. New York, 8, pt. 1, 1892, p. 276.

Leptaena, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 708. (*See* for full synonymy).

The description given by Hall and Clarke is too long to quote in full. The following quotations, however, give a fairly full account of the genus:

> Shells plano-convex when young, concavo-convex at maturity; convexity normal. Surface covered by conspicuous concentric corrugations or wrinkles over the flatter portions of the valves. Where these cease the surface is more or less abruptly and often rectangularly deflected, forming a conspicuous anterior slope. The whole exterior is covered with fine, even, radiating, thread-like tubular striae, which in well preserved specimens, are crenulated by finer concentric striae. Outline transversely subquadrate or semi-oval. Hinge-line straight, its length making the greatest diameter of the shell; extremities often subauriculate. Cardinal area narrow, slightly wider on the pedicle valve, not denticulate. In the pedicle valve, the delthyrium is covered by a convex deltidium, perforated at the apex by a foramen which is closed at maturity or encroaches upon the apex of the valve. This deltidium is most conspicuously developed in early stages of growth, then having the form of a tube or sheath, which character becomes obliterated as maturity approaches, by the increase in the size of the cardinal process of the opposite valve, and the callosities formed about its base. In adult shells the foramen has become enclosed by the substance of the shell, its external opening being an oblique groove in front of the apex of the valve, and its inner aperture appearing in front of the pedicle scar. Not infrequently the passage is closed at maturity.

Leptaena rhomboidalis (*Wilckens*)

Plate VII, Figure 12.

Conchita rhomboidalis, *Wilckens.* Nachricht von selten Versteinerungen, 1769, p. 77, pl. 8, figs. 43, 44.

Strophomena depressa. *Billings.* Can. Nat. & Geol. 1, 1856, p. 59, pl. 1, fig. 5.

Leptaena depressa, *Hall.* Pal. New York, 2, 1852, p. 62, pl. 21, fig. 8, p. 257. pl. 53, fig. 6.

Strophomena rhomboidalis, *Billings.* Can. Jour., 6, 1861, p. 336, figs. 111, 112.

Strophomena rhomboidalis, *Chapman.* Expos. Min. Geol. Canada, 1864, p. 115, fig. 6; p.193, fig. 232.

Leptaena rhomboidalis, *Hall and Clarke.* Pal. New York, 8, pt. 1, 1892, p. 279, pl. 8, figs. 17-31, pl. 15a, figs. 40-42, pl. 20, figs. 21-24.

Leptaena rhomboidalis, *Cumings.* 32nd Ann. Rep. Dept. Geol. Nat. Res. Indianna, 1908, p. 909, pl. 34, figs. 5-5d.

Hall's description is as follows:

> Shell semioval or semicircular; hinge-line equal to, or extending beyond, the width of the shell; dorsal valve having the upper part nearly flat, slightly convex or even concave, with strong concentric undulations towards the margin abruptly inflected; ventral valve parallel to the dorsal valve, presenting a deep concavity. Surface marked by prominent radiating striae.

> The cardinal area is narrow, and extended to the extremities of the hinge-line; the foramen is broad and spreading, but filled by a callosity of the ventral valve, which has a narrow groove at its summit for the protrusion of the pedicle; the apex of the dorsal valve is often, and perhaps always, perforated. [1]
>
> The flatter portions of both valves are strongly marked by concentric undulations, which are crossed by finer striae. On the deflected portion there are no undulations, the striae alone marking the surface. Sometimes the shell is nearly flat, the deflected portion being either very narrow, or not at all conspicuous. The undulations are variable in number, even in shells of the same size, and not to be relied upon as characteristics; and in very old shells they are not so strong as in younger ones, or those of medium size. The striae crossing the undulations are likewise variously prominent in different individuals, frequently bifurcating, and in well-preserved surfaces are crossed by fine concentric striae. The interior structure is always peculiar and sufficiently characteristic, though the exterior characters are very closely simulated by a different shell in the shaly limestone of the Helderberg.

This species is of fairly common occurrence at Toronto but usually only the dorsal valves are found. The undulations are comparatively low and variable, usually numbering from 13 to 15. The anterior margin is less strongly inflected than in specimens of this species from other localities and horizons. Our examples seem to conform most closely to those from the lower rocks of the type locality which are smaller, less strongly inflected, and with fewer undulations than those from the higher strata.

While this species is so well marked that its identification is comparatively easy, detailed study of recent years has led to the recognition of a number of varieties. Foerste is inclined to regard the specimens from the Don as near, if not identical with, his variety *L. rhomboidalis invenusta.* The specimen used for the figure which is a fairly large example is 23.3 mm. across the hingleline, 14.2 mm. in maximum length.

Locality.—Don brickyard, Toronto.

Nos. 1109 H.R. and 1110 H.R. Royal Ontario Museum of Paleontology.

Genus PLECTAMBONITES. *Pander*

PLECTAMBONITES, *Pander.* Beitrage zur Geognosie des Russ. Reiches, 1830, p. 30, pl.3, figs. 8, 16; pl. 28, fig. 19.

PLECTAMBONITES, *Hall and Clarke.* Pal. New York, pt. 1, 1892, pp. 236, 295.

The genus is thus defined by Hall and Clarke:

> Shells usually small, normally concavo-convex. Surface covered with very fine striae, often alternating in size. Hinge line making the greatest width of the shell, the extremities often subauriculate. Cardinal area narrow in both valves, sometimes obscurely crenulated on the margins. Pedicle valve with a moderately broad delthyrium which is partially closed by a convex plate, but mostly occupied by the cardinal process of the opposite valve. Apical foramen sometimes retained. Teeth prominent and supported by thickened plates, which are continued in broad outward curves for more than half the length of the valve, returning and uniting in the umbonal cavity, thus limiting two linguiform muscular scars, enclosing a more or less clearly defined adductor impression.
>
> In the brachial valve, the dental sockets are deep, and often appear to transect the cardinal area. The cardinal process is simple and erect but by its coalescence with the short prominent crural plates, the posterior face appears trilobate. The crural plates end abruptly as in *Orthothetes* becoming thickened at about the middle of their length, giving origin to two low ridges or septa, which at first approach each other, and thence continue forward with a slight divergence, thus forming the inner boundaries for two elongate muscular scars, which are less sharply defined on their outer margins. The muscular area is rendered quadripartite by two short transverse or oblique posterior furrows. Vascular impressions radial, sometimes digitate. Shell substance fibrous, sparsely punctate

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[1] Hall's use of the terms "dorsal" and "ventral" is the reverse of the modern.

PLECTAMBONITES SERICEUS (*Sowerby*)

Plate VII, Figures 15 and 16.

LEPTAENA SERICEA, *Sowerby*. Murchison's Sil. Sys., 1839, pl. 19, figs. 1, 2.
LEPTAENA SERICEA, *Hall*. Pal. New York, 1, 1847, pp. 110, 287, pl. 31b, fig. 2; pl. 79, fig. 3.
LEPTAENA SERICEA, *Billings*. Geol. Can., 1863, p. 163, fig. 139.
STROPHOMENA SERICEA, *Emmons*. Amer. Geol. 1, pt. 2, 1855, p. 199, pl. 2, fig. 6 a-f.
STROPHOMENA SEMIOVALIS, *Vanuxem*. Geol. New York, Rep. 3rd Dist., 1942, p. 37.
PLECTAMBONITES SERICEA, *Shaler*. Mem. Surv. Kentucky, 1, 1876, p. 28.
PLECTATAMBONITES SERICEUS, *Cumings*. 32nd Ann. Rep. Dept. Geol. Nat. Res. Indiana, 1908, p. 922, pl. 36, figs. 1-1c.
PLECTAMBONITES SERICEUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 997. (See for more complete synonymy).

Sowerby's original description follows:

> Semicircular; finely striated longitudinally, with a silky lustre; a few striae deeper than the others; larger valve convex, the other nearly flat; front not concave, considerably deflected at the edge. Length five lines, width ten lines.
>
> In general form this resembles *L. lata* of the Ludlow rocks, but has much finer striae and more angular sides. The front also is straighter, and there are no indications of spines. Sometimes a few concentric lines of growth are conspicuous.

Plectambonites sericeus, originally described from Europe, occurs in North America in strata from the Trenton to the Richmond, sometimes in enormous numbers. At Toronto it is exceedingly common in the upper layers at the Don brickyard: is rare or absent in the lower layers on the Humber; but recurs, perhaps with a varietal difference, in the highest layers at Weston.

The elongate shape of the shell and its silky, fibrous structure when broken serve best for its identification. Young specimens are much less elongate, however, and care must be taken in this respect. A species of such long range and wide distribution naturally shows minor variations such as varying size, the degree of prolongation of the cardinal angles, and more or less departure from the semicircular form by a straightening of the anterior margin. All our specimens are fairly constant in form and agree with the example figured which is of average size—22 mm. wide and 8.5 mm. long. It will be observed that the length is less than half the width.

Locality.—Don brickyard, Toronto.
No. 1109 H.R. Royal Ontario Museum of Paleontology.

PLECTAMBONITES *cf.* RUGOSUS (*Meek*)

Plate VII, Figure 11.

LEPTAENA RUGOSA, *James*. Cat. Foss. Cincinnati Group, 1871.
LEPTAENA SERICEA *var* RUGOSA, *Meek*. Pal. Ohio, 1, pt. 2, 1873, pl. 5, figs. 3f, g, h.
PLECTAMBONITES RUGOSA, *Foerste*. Bull. Sci. Lab. Denison Univ., 17, 1912, p. 123, pl.1, figs. 7a-c; pl. 10, figs. 7a-d.
LEPTAENA ASPERA, *James*. Cincinnati Quart. Jour. Sci., 1, 1874, p. 151.
PLECTAMBONITES SERICEUS *var.* ASPER *Ruedemann*. Bull. New York State Museum, 49, 1901, p. 18, pl. 1, figs. 6, 7; ibid., 8, p. 525.

James described as *Leptaena rugosa* a species of *Plectambonites* which seems to differ from *P. sericeus* in two features which have been considered in some detail by Foerste (*op. cit.*). One of these characteristics is the presence of a number of oblique crenulations along the cardinal margin of both valves. Similar crenulations occur in many other brachiopods which are normally without them and may, therefore, be of no specific value. The other determinative feature of *Leptaena rugosa* is "the roughened surface of the general exterior surface of the valves, especially anteriorly. This roughened surface appears due to the presence of numerous very thin overlapping films of shell material." The name *rugosa* refers to the latter characteristic and not to the presence of the crenulations. Meek, however, refers only to the crenulations in the text accompanying his figures. Ruedemann, also, seems to regard the crenulations and the somewhat straighter anterior margin as characteristic.

Accompanying normal examples of *Plectambonites sericeus* in the rocks at Toronto and Weston are a number of closely related forms differing in the possession of oblique corrugations along the hinge line which may be but faintly developed or which may be quite marked. Smaller forms do not differ markedly in outline from normal examples of *Plectambonites sericeus* and even some of larger size are essentially similar in shape. Extreme types, however, with well developed corrugations are decidedly more mucronate and apparently with a slight sinuous indentation of the anterior margin. The specimen figured is one of the most extreme encountered. In no case was any evidence observed of the rugose characteristic, *i.e.*, of the roughening of the exterior by thin overlapping films of shell-matter.

These shells are undoubtedly close to *Plectambonites rugosus* which is recognized by authorities as a distinct species; we feel compelled, therefore, to place our specimens under that species. Nevertheless, lacking any evidence of the "rugose" characteristic, and observing transitions in the crenulations from the extreme types to normal *P. sericeus*, it might be more advisable to adopt the views of Meek and of Ruedemann leaving these crenulated forms under *P. sericeus* with a varietal distinction *rugosus*.

Locality.—Don brickyard, Toronto.
No. 1111 H.R. Royal Ontario Museum of Paleontology.

Genus Rafinesquina, *Hall and Clarke*

Rafinesquina, *Hall and Clarke*. Pal. New York, 8, pt. 1. 1892, p. 281.
Rafinesquina, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 1084. (See for full synonymy).

The original description of this genus is as follows:

> Shells normally concavo-convex. Surface ornamented by radiating striae, of alternating size, crossed and crenulated by finer concentric striae. Cardinal margins without denticulations. Interior of the pedicle valve with the muscular area not strongly limited; consisting of two broad flabellate diductor scars enclosing an elongate, more distinctly defined adductor. The faintness of the limitation of this area is in marked contrast to the sharply defined muscular area in the corresponding valve of *Leptaena*. In the brachial valve the cardinal process is more closely sessile than in *Leptaena*, and there is frequently a linear callosity between the branches. The posterior adductor scars have the aborescent markings of *Leptaena rhomboidalis*, and these impressions are the only ones well defined, the anterior scars being narrow and rarely retained with distinctness. From the anterior margin of the muscular area radiate a series of irregular furrows and nodose ridges, which are to some extent of vascular origin.

Rafinesquina alternata (*Emmons*)

Plate VII, Figure 18.

Strophomena alternata, *Emmons*. Geol. New York, Rep. 2nd Dist., 1842, p. 395, fig. 3.
Leptaena alternata, *Hall*. Pal. New York, 1, 1847, pp. 102, 286, pl. 31, fig. 1; pl. 31A, fig. 1; pl. 79, fig. 2.
Rafinesquina alternata, *Hall and Clarke*. Pal. New York, 8, pt. 1, 1892, p. 282, pl. 8, figs. 6-11, 27, 28; pt. 2, 1895, pl. 84, figs. 17, 18.
Rafinesquina alternata, *Bassler*. U.S. Nat. Mus., Bull 92, 1915, p. 1085. (*See* for the very lengthy synonymy).

The description of this species given by Hall is as follows:

> Broadly semioval; length and breadth about as 12 to 15; hinge line, in perfect specimens, a little longer than the width of the shell, slightly reflected at the extremities, which sometimes become short acute ears; cardinal area narrow, the callosity of the

ventral valve nearly filling the triangular foramen of the dorsal valve; beak uniformly perforated with a minute circular opening; dorsal valve depressed convex, sometimes more convex in the middle, suddenly deflected near the margin and flattened towards the cardinal line; ventral valve concave, gradually or sometimes suddenly inflected towards the basal margin; surface marked by fine rounded radiating striae, which alternate at unequal intervals with coarser ones; striae increasing in number towards the margin of the shell, crossed by fine elevated concentric lines and a few imbricating lines of growth.

In this species the striae are usually of two sizes, the coarser and more elevated ones having from four to six finer ones between; the latter increase in number as they recede from the apex, and one of them, in the centre of the fascicle, becomes enlarged and rises above the others. Some of the specimens figured are strongly marked individuals, where these characters are very distinctly preserved; but there are many variations from the type of the species, and some others where it is difficult to decide their true relations when we have not a series showing their gradations.

The characteristic developments of the shell depend on the circumstances of its existence and the nature of the sediments. There are other differences which are due to causes beyond our knowledge; for, in the same locality, and where great numbers of them must have lived under precisely similar circumstances, we find considerable variation in character. In the compact limestones of New York, where, in splitting the rock, a portion of the shale often exfoliates, we find a great deviation from the type of the species. The age of the shell also exerts considerable influence upon its external form. The young ones, or those of medium size, are usully symmetrical shells, moderately convex, and gently curving towards the base. The striae in such individuals are distinctly in fascicles of from four to six, separated by stronger and more elevated single ones on either side; as the shell increases, this uniformity in the arrangement often disappears, and the striae appear of uniform size, or alternate irregularly. The concave or ventral valves, particularly in old specimens, have the striae nearly uniform in size.

From the above description it will be seen that we have to deal with a shell subject to much variation which has led to the founding of a number of varieties since the species was established. A careful comparison of our specimens with these varieties leads to the conclusion that the Toronto examples are nearest to the type, varying chiefly in the loss of distinct alternation of striae in older specimens and the development of a somewhat pustulose character along the line where the convex valve is deflected towards the anterior margin. The form figure has the following dimensions; width along hinge line, which is slightly less than the greatest width of the shell, 33.3 mm.; length, 29.2 mm.

Locality.—Humber river, Bloor Street crossing, Toronto.
No. 1112 H.R. Royal Ontario Museum of Paleontology.

RAFINESQUINA MUCRONATA, *Foerste.*

RAFINESQUINA MUCRONATA, *Foerste.* Bull. Sci. Lab. Denison Univ., 17, 1914, p. 365, pl. 2, figs. 7a, b.

RAFINESQUINA ALTERNATA, *Foerste.* Geol. Surv. Can. Mem. 83, 1916, p. 74-

Foerste described this species from types obtained on the Nicolet river, Quebec; he also records its occurence at Weston. The description follows:

Shell small, the length about three-fifths of the width, but varying in different individuals. Usually slightly extended along the hinge line beyond the middle width of the shell so as to produce a small mucronate projection; but some individuals have rectangular posterolateral outlines. Usually obliquely wrinkled along the hinge line. Radiating striae fine, with every fourth one distinctly more conspicuous along the middle and anterior parts of the valve; usually the stria found along the median line of the shell is more conspicuous than any of the remainder. Pedicle valve only moderately convex, the brachial valve slightly concave almost flat.

The species appears closely allied to *Rafinesquina squamula*, James, from the Fairmount beds in the lower part of the Maysville division of the Cincinnatian strata in Ohio. The latter, however, is not so characteristically mucronate at the ends of the hinge line, nor so characteristically obliquely wrinkled along the posterior margin.

Foerste (*op. cit.*) records this species from Weston, but we have not seen any specimens that can unhesitatingly be ascribed to it.

RAFINESQUINA MUCRONATA TORONTONENSIS, *var. nov.*

Plate VII, Figures 13, 14, 17.

In many of the exposures along the Humber river there occur scattered examples of a small strophomenoid shell very closely resembling *Rafinesquina mucronata*. They occur in particular abundance in a narrow band of yellowish-grey shale, near the water level immediately below the road bridge at Lambton.

In general shape, mucronate character, and degree of convexity of the valves these shells agree with *Rafinesquina mucronata*. They differ, however, in that no trace of the oblique crenulations along the posterior margin was observed, and there is no evidence of every fourth stria being more conspicuous.

A striking feature of the shell is the strong development of the median stria which is most pronounced in younger specimens. The remaining striae are rounded and almost equal in strength. In the better preserved specimens from the arenaceous limestones the radiating striae are crossed by very delicate concentric lines. The absence of crenulations along the hinge line suggests that this form is more closely related to *R. squamula*, U. P. James, but that species is not characterized by a strongly developed middle stria. There is also a very close resemblance to *Leptaena* (*Rafinesquina*) *mesacosta*, Shumard; size, shape, character of radiating and concentric striae, strong median stria, and mucronate cardinal angles all agree very closely. The much higher horizon of *Leptaena mesacosta* (Silurian), however, seems to make the identity of the two species impossible.

Figures 13 and 14 represent the pedicle and brachial valve respectively of an average specimen from the shale bed near the Lambton bridge. Width, 14 mm., length 10 mm. Figure 17 represents a younger specimen from the old mill-race near the Humbervale quarry; it will be observed that the median stria is more conspicuous in this example.

Locality.—Mill-race, Humbervale quarry; water level below bridge at Lambton. Nos. 1113 H.R., 1114 H.R. Royal Ontario Museum of Paleontology.

STROPHOMENA INCURVATA (*Shepard*)

PRODUCTA INCURVATA, *Shepard*. Amer. Jour. Sci., 34, 1838, p. 144, figs. 1, 2.

LEPTAENA FILITEXTA, *Hall*. Pal. New York, 1, 1847, p. 111, pl. 31B, fig. 3.

STROPHOMENA FILITEXTA, *Billings*. Canadian Nat. Geol., 1, 1856, p. 203, figs. 1, 2.

STROPHOMENA FILITEXTA, *Nicholson*. Pal. Prov. Ontario, 1875, p. 34, figs. 10, a, b.

STROPHOMENA INCURVATA, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 1229, (See for complete synonymy).

Nicholson (*op. cit.*) states that this species is abundant in the Hudson River group at Weston, and Wood point, Georgian bay. We have not observed the form in our somewhat extensive collections from Weston and as it is a characteristic fossil of the Stones River and Black River formations, its occurrence at Weston is at least doubtful despite Nicholson's assertion.

In the genus *Strophomena* the valves are concave-convex in the opposite direction from that which maintains in *Rafinesquina*, *i.e.*, the pedicle valve is concave and the brachial valve convex. The species, *S. incurvata* has a general resemblance to *Rafinesquina alternata* but it is distinguished by the uniformity of the radiating striae and the fine concentric striae are so conspicuous as to give the surface a woven appearance.

Order TELOTREMATA

Family RHYNCHONELLIDAE

Genus Rhynchotrema

Rhynchotrema increbescens (*Hall*)

Atrypa increbescens, *Hall*. Pal. New York, 1, 1847, pp. 146, 289, pl. 33, figs. 13 a-h; pl. 79, fig. 6.

Rhynchotrema increbescens, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 1125, (*See* for full synonymy).

In the "Geology of Canada, 1863", page 213 this species is recorded as occurring on the Humber river. We have been unable to identify it: the form referred to is probably *Zygospira cincinnatiensis*.

Family ATRYPIDAE

Genus Zygospira, *Hall*

Stenochisma, *Hall* (non Conrad). Pal. New York, 1, 1847, p. 142.
Stenochisma, *Meek and Hayden*. Pal. Upper Missouri Smith. Con. to Knowl., 14, 1864, p. 16.
Zygospira, *Hall*. 15th Rep. New York State Cab. Nat. Hist., 1862, p. 154, figs. 1-2.
Zygospira, *Hall and Clarke*. Pal. New York, 8, pt. 2, 1894, p. 154.
Anazyga, *Davidson*. Brit. Sil. Brach., Sup., Pal. Soc., 1882, p. 128.
Hallina, *Winchell and Schuchert*. Prel. Desc. Am. Geol., 9, 1892, pp. 291-292.
Protozyga, *Hall and Clarke*. Pal. New York, 8, pt. 2, 1894, p. 151.
Orthonomaea, *Hall and Clarke*. 47th Rep. New York State Mus., 1894, p. 1008.

Hall and Clarke's description of this genus is as follows:

> Shells usually small. Outline subcircular or transversely oval. Contour sub-plano-convex. Surface sharply plicate. Pedicle valve with a median plicated ridge. Umbo narrow and prominent ; deep acute and incurved. Foramen elongate, rarely apical, enclosed by the deltidial plates. Hinge line long and straight; cardinal extremities rounded. A distinct false area is formed by a pair of ridges diverging from the beak toward the cardinal extremities. On the interior the teeth are moderatelyt well developed and unsupported by dental lamellae.
>
> The brachial valve is depressed convex in the umbonal region and bears a more or less conspicuous median sinus. The hinge plate consists of two broad, stout processes, diverging outwardly, grooved on their summits, and separated from each other by a narrow, sharp crest. They form both the socket walls and crural bases, and are supported by a low median ridge. Muscular impressions obscure in the typical species.
>
> The crura are short and straight at their union with the primary lamellae, making a rectangular curve. The first half-volution of the ribbon lies just within the margin of the valve, and the number of volutions is small. The spirals have their bases parallel to the lateral slopes of the pedicle valve and their apices directed obliquely toward the centre of the opposite valve. The loop is a continuous band, variable in position and shape. It may originate on the posterior or anterior limb of the primary lamellae, or be placed medially; its apex is always angular and directed anteriorly and the lateral curves vary in length and degree according to their position with reference to the spirals.

The rocks at Toronto contain great numbers of small shells referable to the genus Zygospira. The largest of these is *Zygospira erratica*. Most of the smaller shells are so badly crushed that specific determination can not be made with great certainty. They fall, however, into two groups characterized, in the crushed condition, only by a greater or less number of plications. The better preserved shells show additional features by which they may be distinguished. We are of the opinion that the form with fewer plications may be ascribed to *Zygospira cincinnatiensis*, Meek, and that the type with more numerous plications is *Zygospira modesta*, Hall.

Zygospira modesta, *Hall*

Plate VII, Figures 19 and 22.

Atrypa modesta (*Say*) *Hall*. Pal. New York, 1, 1847, p. 141, pl. 15, fig. 15.
Zygospira modesta, (*Say*) *Hall*. 15th Rep. New York State Cab. Nat. Hist., 1862, p. 154.
Rhynchonella modesta, *Billings*. Geol. Surv. Canada, Rep. 1863, p. 211, fig. 211.
Zygospira modesta, *Meek*. Pal. Ohio, 1, 1873, p. 125, pl. 11, fig. 4.
Zygospira modesta, *Foerste*. Bull. Sci. Lab. Denison Univ., 16, 1910, p. 29, pl. 2, figs. 15a-b.
Zygospira modesta, *Foerste*. Geol. Surv. Canada. Mem. 83, 1916, pp. 22, 23.
Zygospira modesta, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 1341. (See for full bibliography).

Meek's description (*op. cit.*) is as follows:

> Shell small rather depressed, nearly plano-convex, sub-orbicular, or sometimes a little wider than long; posterior lateral margins straightened and converging to the beaks at an obtuse angle; lateral margins more or less rounded, or sometimes a little straightened, or very slightly sinuous at the middle.
>
> Dorsal valve, with a rather shallow, undefined mesial sinus of moderate breadth at the front, but becoming rapidly narrower, and less impressed posteriorly, so as often to die out before reaching the umbo; surface on each side of the sinus gently convex centrally, and gradually sloping to the lateral margins; beak but slightly prominent and incurved.
>
> Ventral valve, with a low mesial ridge, corresponding to the sinus of the other valve, excepting that it is generally most prominent near the middle, and somewhat depressed anteriorly; while on each side of the ridge the slopes are distinctly compressed; beak small, abruptly pointed, projecting beyond that of the other valve, and rather distinctly arched; but not so closely incurved as to conceal the small fissure, which seems to be closed below by a deltidium, that leaves a minute aperture above, just under, or extending to the apex; margin on each side of the beak carinated, so as to give the appearance of a kind of false cardinal area.
>
> Surface of each valve ornamented by about 16 to 18 small, simple radiating plications, of which about three to five near the front of the dorsal valve occupy the mesial sinus, the middle one being usually a little the largest; while on the ventral valve about four of the largest occupy the mesial prominence, the furrow between the middle two being generally a little larger and deeper than the others; marks of growth undefined, or extremely minute and obscure.
>
> Length of mature, moderately large specimen, 0.26 inch; breadth, 0.30 inch; convexity, 0.15 inch.

Foerste (*op. cit.*) redescribes the species and gives the additional information that the type specimen is 7.8 mm. long, 9.2 mm. wide, and 4.1 mm. thick. He also states that the characteristic features are the low median fold and the rather numerous lateral plications, all of them primary. In the type specimen there are seven of these plications on each side, but the number is frequently eight and sometimes nine. The pedicle valve of the type has eighteen distinct plications and two faint ones near the hinge line. Certain specimens attain a length of 10 mm.

In the Toronto rocks this species is of less frequent occurrence than *Zygospira cincinnatiensis* from which it may be distinguished, even in the flattened condition, by the fact that the brachial valve of the latter seldom shows more than thirteen plications which are of necessity broader and coarser in specimens of the same size.

The largest brachial valve observed is 10 mm. wide and shows twenty-one plications in all. The sinus is scarcely observable and there is some tendency towards bifurcation in the plications, a feature not generally admitted for *Z. modesta*. A typical brachial valve from Toronto is shown in Plate VII, Figure 22. Despite our large collections, a really good pedicle valve suitable for reproduction was not found: in consequence, a specimen from Manitowaning has been used to illustrate this valve.

The dimensions of the brachial valve are: length, 6 mm.; width, 7.8 mm. The sinus is shallow and inconspicuous and the anterior margin without sinuosity. There are nineteen distinct non-bifurcating plications of which the middle one is larger and more rounded.

Locality.—Don Valley brickyard, Toronto.
Manitowaning, Ontario.
Nos. 584 H.R., 600 H.R. Royal Ontario Museum of Paleontology.

ZYGOSPIRA CINCINNATIENSIS, *Meek*

Plate VII, Figures 20, 21, 23.

ZYGOSPIRA CINCINNATIENSIS, *James*. Cat. Fossils Cin. Group, 1890, p. 11.

ZYGOSPIRA CINCINNATIENSIS, *Meek*. Pal. Ohio, 1, 1873, p. 126, pl. 11, fig. 5.

ZYGOSPIRA CINCINNATIENSIS. *Hall and Clarke*. Pal. New York, 8, pt. 2, 1895, pl. 54, figs. 13, 14.

ZYGOSPIRA CINCINNATIENSIS, *Cumings*. 32nd Ann. Rep. Dept. Geol. Nat. Res. Indiana. 1908, p. 945, pl. 36, figs. 9a-b.

ZYGOSPIRA CINCINNATIENSIS, *Foerste*. Bull. Sci. Lab. Denison Univ., 16, 1910, p. 30, pl. 6, figs. 16 a-b.

Meek's description of this species follows:

> This variety or species differs from the last (*Z. modesta*), in its larger size, greater proportional breadth, more prominent mesial elevation, with a larger and deeper sulcus along its middle, and in the deeper mesial sinus of its dorsal valve. and the more spreading character of its lateral plications. Its plications likewise differ in being proportionally coarser, and more angular, and more frequently show a disposition to bifurcate, particularly those on the sides of the mesial elevation of the ventral valve, and within or near the mesial sinus of the dorsal valve. Its lateral margins are likewise generally more compressed; and the beak of its ventral valve more strongly incurved.
>
> Under a strong magnifier, in a favorable light, extremely minute, regular, and closely crowded concentric striae may sometimes be seen on the sides of the plications, and other protected parts of the shell. These are similar to those sometimes seen on the last, but more distinct.
>
> Although this is possibly a distinct species from the last, it would, I should think, be rather difficult to distinguish young or small examples of it from that shell. Hence I am inclined to think that it may be only a robust variety of the same.
>
> Length of one of the largest examples, 0.41 inch; breadth, 0.52 inch; convexity, 0.25 inch.

Later authors have been inclined to regard the species as distinct; for instance, Foerste (*op. cit.*) makes the following statement:

> The specimens from the upper Fairmount, which are here regarded as typical, are distinguished from *Zygospira modesta* by the smaller number of primary lateral plications, usually five on each side of the median fold. In consequence, the plications appear larger, more angular, and more distant from each other. The more prominent median elevation on the pedicle valve is due chiefly to the larger size of the individuals. The four primary plications on the median fold and the intermediate grooves have very much the same appearance as in *Zygospira modesta*. While the birfucation of the primary plications, or the intercalation of additional ones, is the chief character usually relied upon in diagnosing this species, too much weight must not be given to this feature, since it is not constant, and numerous specimens may be collected at the typical horizon, in which there is no evidence of bifurcation. Among the four primary plications on the median fold, it is the lateral plications, and not the two median plications which frequently are bifurcated. Bifurcation of one or two of the lateral plications on each side of the median fold is not rare. Occasionally even the

two median plications on the fold are bifurcated towards the anterior margin of the shell, or one or two small plications are inserted near the anterior end of the median groove. Some of these specimens attain a length of 13 mm. Only the larger specimens are likely to show evidence of frequent bifurcation.

There is no doubt that our rocks contain a species of *Zygospira* which can be easily differentiated from *Z. modesta* by its fewer and more angular plications: there is little doubt that this form is *Z. cincinnatiensis* as defined by Meek and amended by Foerste. On the other hand, the form figured by Hall and Clarke (Plate 54, figs. 13 and 14 of work cited) does not agree with our interpretation of *Z. cincinnatiensis.*

The brachial valve (Plate VII, figs. 21 and 23) shows the characteristic broad sinus with a rounded median plication. On each side of this, within the sinus, is a much smaller and more angulated plication. The third, or sometimes the fourth, plication forms the edge of the sinus. The lateral plications are sharp, and more curved than in *Z. modesta;* they number four or five, making five or six lateral plications in all, counting the little one next to the median. In all, therefore, there are either 11 or 13 plications on this valve.

The pedicle valve (Plate VII, Fig. 20), owing to the greater prominence of the beak is less ovoid in shape than the brachial valve. The beak is rather pronounced, extended forward, and incurved. The fold, corresponding to the sinus of the other valve, extends well up on the beak: it is marked medially by a rounded groove. Bordering the groove is a small angular plication and outwards from this is a much larger plication marking the boundary of the fold. In addition are four, or sometimes five, lateral plications. Thus the complete valve generally shows 12 plications in all, but as many as fourteen may occur.

Bifurcation of the plications is frequently observed, particularly in the case of the large plication bounding the fold, and occasionally in the case of the lateral plications. The feature is of no specific value, however, as many specimens are devoid of bifurcation and others show it on one side but not on the other.

Zygospira cincinnatiensis is restricted, therefore, as far as the Toronto strata are concerned to those forms with not more than 15 plications on the brachial valve and 14 on the pedicle, and with clearly defined smaller plications on each side of the median line.

The brachial valve shown in figure 21 is one of the largest and most perfect found. The dimensions are: width, 9 mm.; length, 6.5 mm. The specimen shown in figure 23 has dimensions as follows: width, 5.8 mm.; length, 4 mm.

Locality.—Don Valley brickyard, Toronto.

Nos. 558 H.R., 601 H.R., 1115 H.R. Royal Ontario Museum of Paleontology.

ZYGOSPIRA (?) ERRATICA (*Hall*)

Plate VII, Figures 24, 25.

ORTHIS (?) ERRATICA, *Hall.* Pal. New York, 1, 1847, p. 288, pl. 79, fig. 5.

ZYGOSPIRA ERRATICA, *Davidson.* Suppl. Brit. Sil. Brach., Pal. Soc., 1882, p. 126.

CATAZYGA ERRATICA, *Hall and Clarke.* Pal. New York, 8, pt. 2, 1894, p. 158, pl. 54. figs. 17-23.

ORTHONOMAEA ERRATICA, *Hall and Clarke.* 47th Rep. New York State Mus. 1894, p. 1008.

CATAZYGA ERRATICA, *Foerste.* Bull. Sci. Lab. Denison Univ., 17, 1914, p. 266.

ZYGOSPIRA ERRATICA, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 1340.

This species has long been ascribed to the genus *Catazyga* but in the most recent revision—that of Bassler—it is placed, provisionally at least, under *Zygospira* in accord with the view of Davidson.

The definition of the species according to Davidson follows:

> Shell marginally broadly rounded, or slightly broader than long, greatest breadth about the middle, hinge line rather long and nearly straight. Ventral valve convex longitudinally, somewhat carinated or flattened along the middle; beak incurved, beak-ridges sharply defined and leaving between them and the hinge line a narrow flattened space or false area. Dorsal valve convex at the sides, depressed longitudinally along the middle, and presenting a concave line in front. Surface marked by fine, uniform, radiating, raised striae, increasing here and there in number by the interpolation of shorter and smaller ribs.

The genus *Catazyga* was founded on *Athyris headi*, Billings, as genotype; the shell is defined as being more convex than in *Zygospira*, with a low median sinus in both valves and much finer striations. The internal structure is much the same in the two genera.

The present species agrees with *Zygospira* in the form of the shell and with *Catazyga* in the character of the plications. In general appearance it is so close to *Catazyga headi* that the two species are often confused.

With the exception of *Plectambonites sericeus* this is the commonest brachiopod found near Toronto. Most of the limey layers in the western part of the district, on the Humber, Etobicoke, and Mimico rivers, are crowded with shells of *Zygospira erratica*.

Locality.—Humber river, Toronto.

No. 1116 H.R. Royal Ontario Museum of Paleontology.

Since this article was prepared we have found a single crushed example of an ovoid, phosphatic shell which is certainly distinct from any other in our collection. It somewhat resembles *Trematis fragilis*, Ulrich, but fine concentric markings are more prominent than radiating lines of punctae. The form is very like an undescribed species of *Acrothele* figured by Reed from the Ordovician rocks of the Girvan district, No. 1238 H. R. Don valley.

Conclusion

A remarkable feature of the brachiopod fauna at Toronto is the relatively small number of species and the strongly eastern aspect of the assemblage. The abundance of *Plectambonites sericeus* on the Don river, its probable total absence in the lower strata of the Humber, and its recurrence at Weston are facts of stratigraphic importance.

In this article no attempt has been made to indicate the vertical extent of any of the species described: that aspect of the subject is reserved for the section dealing with the stratigraphy. The localities given after each species are those from which the specimens used in the description were obtained.

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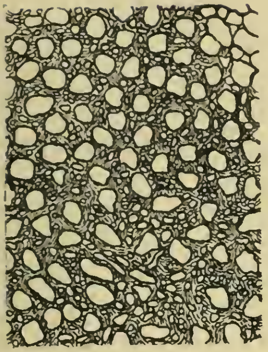
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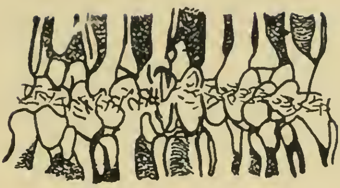
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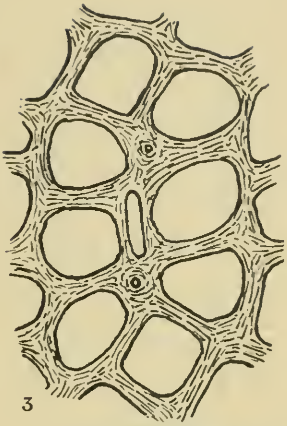
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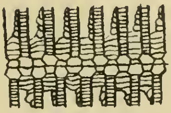
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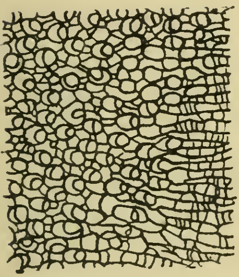
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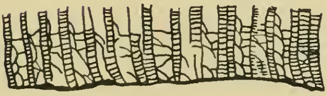
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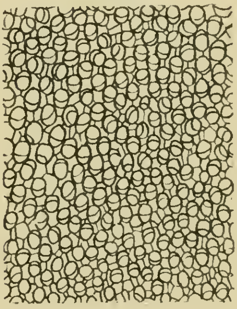
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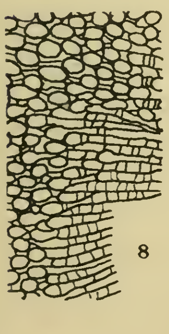
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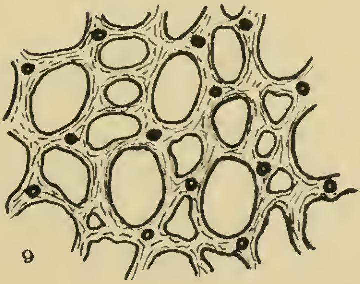
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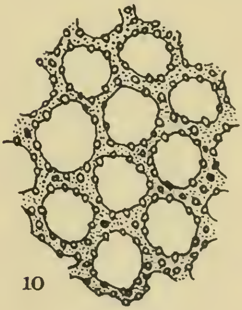
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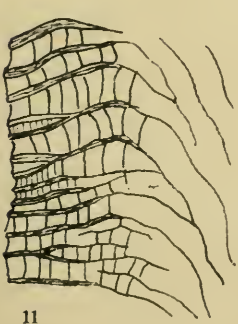
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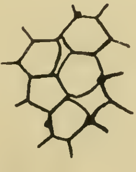
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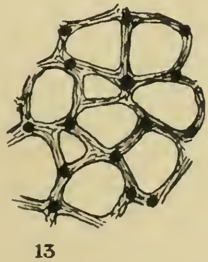
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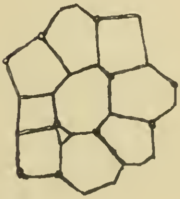
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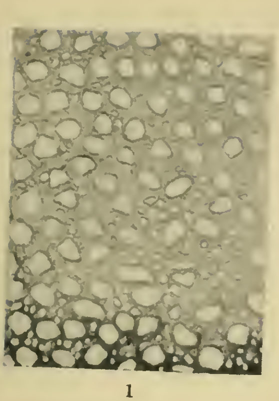

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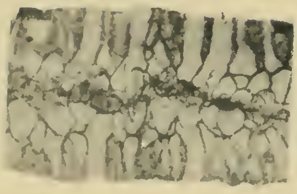

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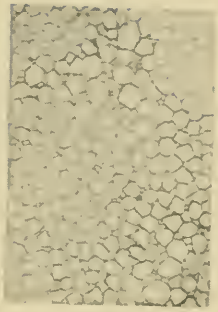

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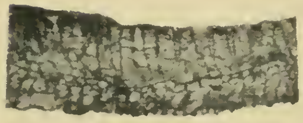

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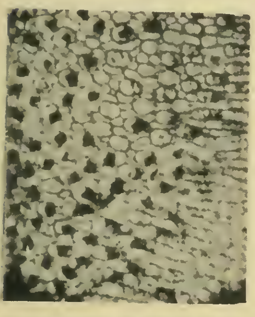

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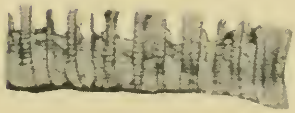

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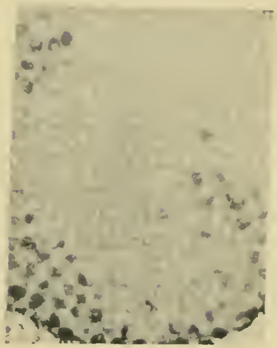

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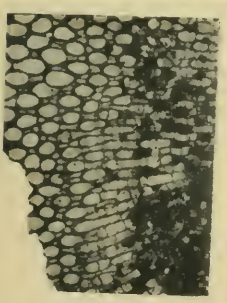

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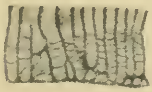

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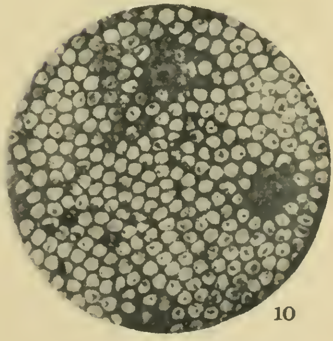

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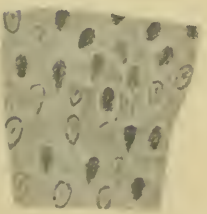

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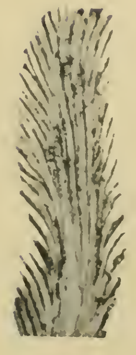

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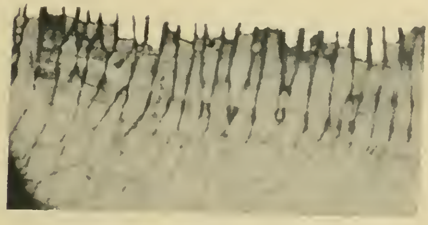

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EXPLANATION OF PLATE III.

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Fig. 4.	*Stigmatella crenulata.* Vertical section × 10	12
Fig. 5.	*Stigmatella crenulata.* Tangential section × 10	12
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Fig. 8.	*Stigmatella catenulata diversa.* Tangential section showing large and small cells × 40	14
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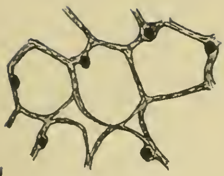
Fig. 11.	*Hallopora dalei subalta.* Vertical section × 10	21
Fig. 12.	*Hallopora* cf. *suplana.* Vertical section × 10	19
Fig. 13.	*Hallopora* cf. *subplana.* Tangential section × 10	19

Plate III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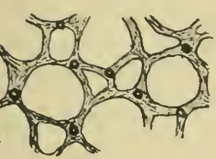
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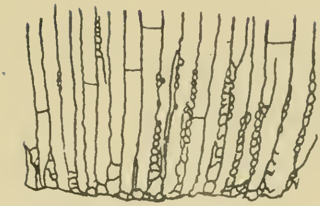
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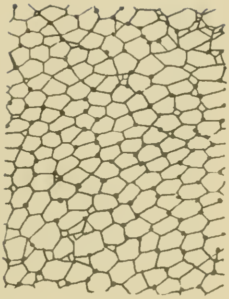
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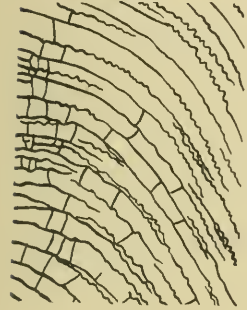
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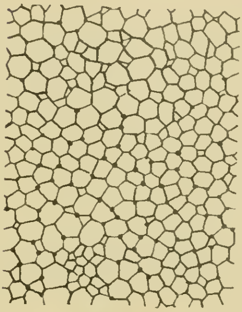
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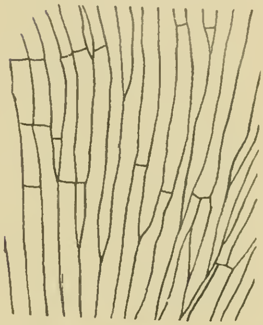
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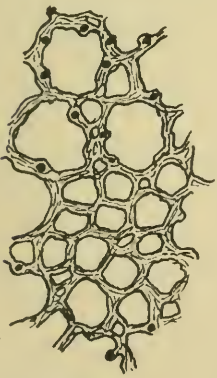
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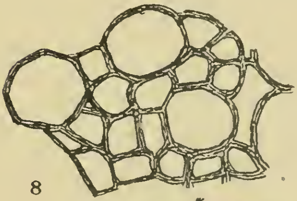
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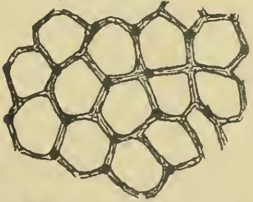
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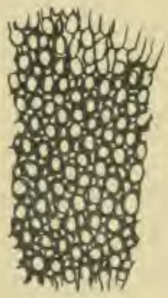
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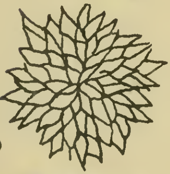
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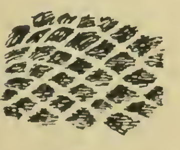
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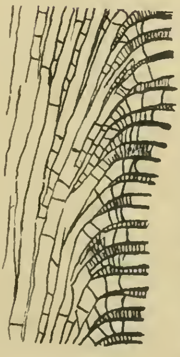
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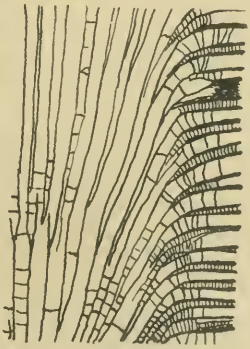
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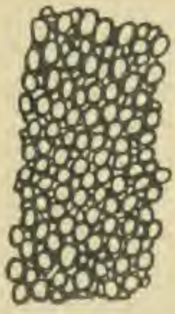
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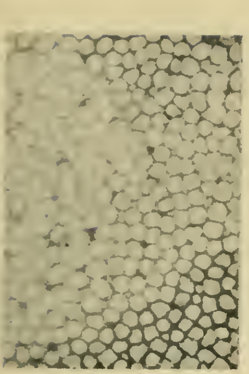
Explanation of Plate IV.

All figures × 10 Fig. 10 which is × 50.

Fig. 1. *Stigmatella catenulata (var. a.)* Tangential section 12
Fig. 2. *Stigmatella catenulata (var. a.)* Vertical section 12
Fig. 3. *Stigmatella catenulata (var. b.)* Tangential section 12
Fig. 4. *Stigmatella crenulata.* Vertical section 12
Fig. 5. *Stigmatella crenulata.* Tangential section 12
Fig. 6. *Stigmatella* cf. *personata.* Vertical section 16
Fig. 7. *Stigmatella* cf. *personata.* Tangential section 16
Fig. 8. *Hallopora dalei var. subalta.* Tangential section 21
Fig. 9. *Hallopora* cf. *subplana.* Transverse section 19
Fig. 10. *Hallopora dalei subalta.* Tangential section × 50 21
Fig. 11. *Hallopora dalei subalta.* Transverse section 21
Fig. 12. *Hallopora dalei subalta.* Vertical section 21
Fig. 13. *Hallopora* cf. *subplana.* Vertical section 19
Fig. 14. *Hallopora* cf. *subplana.* Tangential section 19

Plate IV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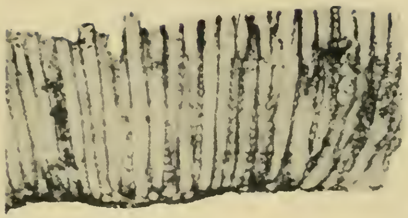
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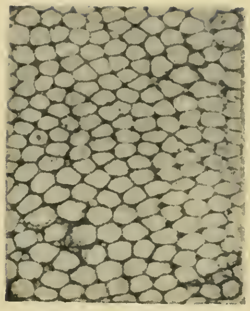
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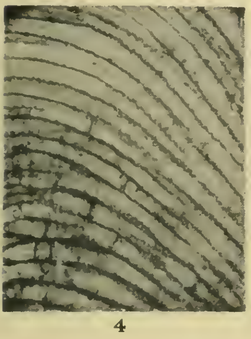
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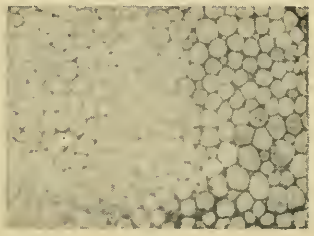
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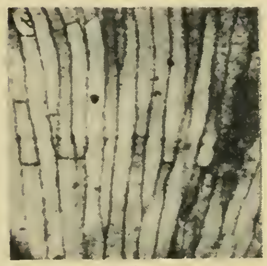
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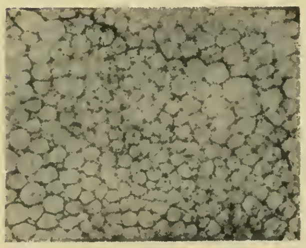

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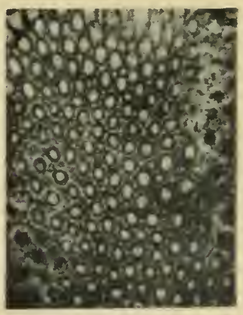

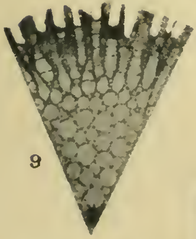
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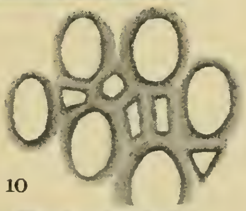

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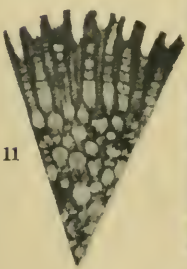

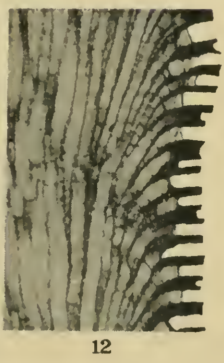
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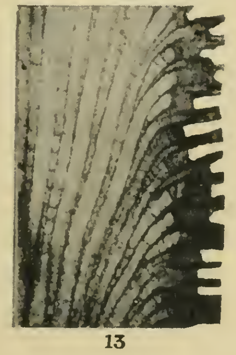
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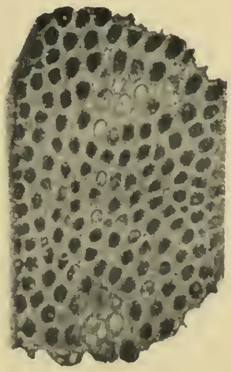
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EXPLANATION OF PLATE V.

All figures are photographs of surfaces enlarged ten times.

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Fig. 11. *Bythopora arctipora*	18
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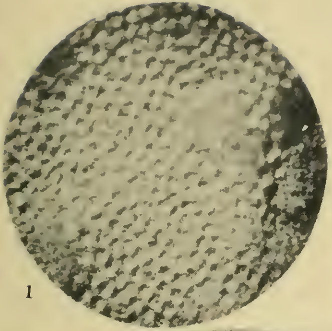
Plate V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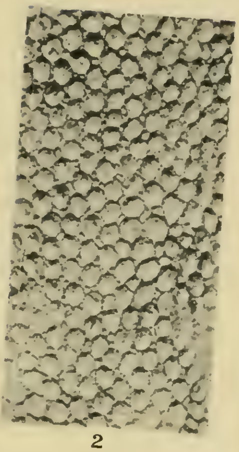
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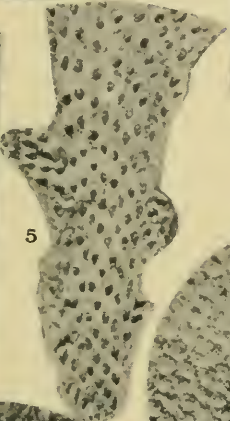
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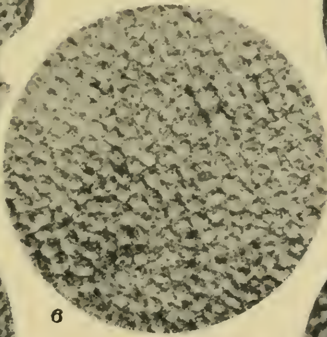
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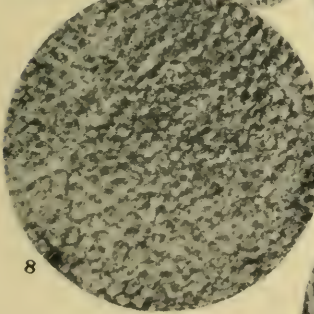
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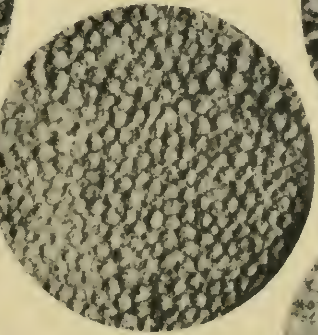
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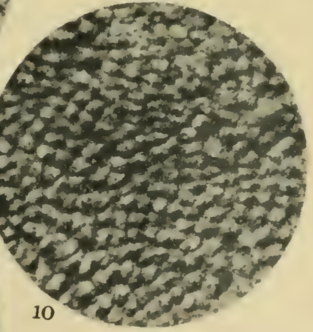
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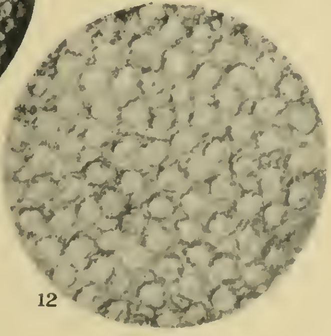
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Explanation of Plate VI.

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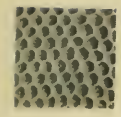
Fig. 9.	*Hallopora* cf. *subplana.* Fragments of zoaria, nat. size	19
Fig. 10.	*Atactopora maculata.* Fragment of zoarium, nat. size.	8
Fig. 11.	*Chiloporella flabellata.* Lower portion of fan-like zoarium, nat. size.	2
Fig. 12.	*Stigmatella vulgaris.* Almost complete zoarium, nat. size.	15

Plate VI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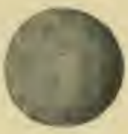
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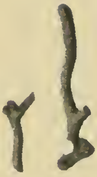
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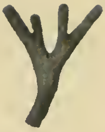
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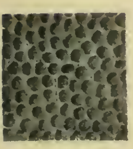
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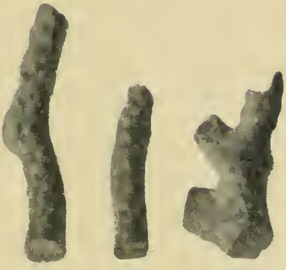
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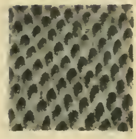
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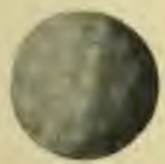
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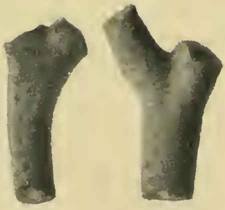
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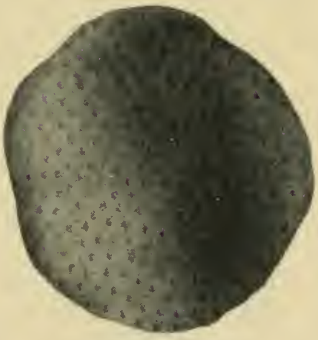
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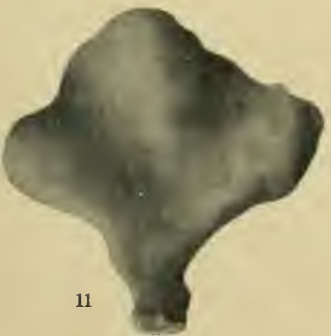
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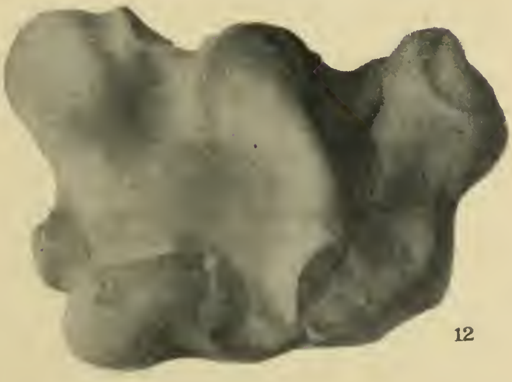
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Plate VII

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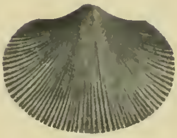
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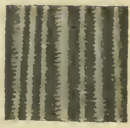
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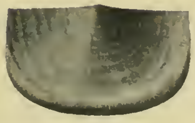
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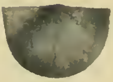
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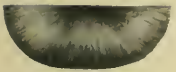
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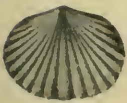
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Engineering

Ontario. Dept. of Mines
Annual report

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PROVINCE OF ONTARIO
DEPARTMENT OF MINES

Hon. H. Mills, Minister of Mines. Willet G. Miller, Provincial Geologist.

Map No. 30b.

PART OF THE
GOWGANDA SILVER AREA
DISTRICT OF TIMISKAMING

To accompany Report of A. G. Burrows in Volume 30, Ontario Department of Mines Report, 1921.

Scale 1/63,360 or 1 Mile = 1 Inch
Chains 80 40 0 1 2 3 4 Miles

First Edition, 1910.
Second Edition, 1921

LEGEND

Glacial and Recent
☐ *Sand and Gravel.*

PRE-CAMBRIAN

Post-Keweenawan
/ *Olivine diabase, quartz diabase.*

INTRUSIVE CONTACT

Keweenawan (Nipissing)
🟧 *Quartz diabase.*

INTRUSIVE CONTACT

Animikean (Cobalt series)
🟨 *Arkose, quartzite, and conglomerate.*
🟫 *Conglomerate, greywacke, quartzite.*

UNCONFORMITY

Laurentian ?
▨ *Granite, syenite, gneiss.*

INTRUSIVE CONTACT

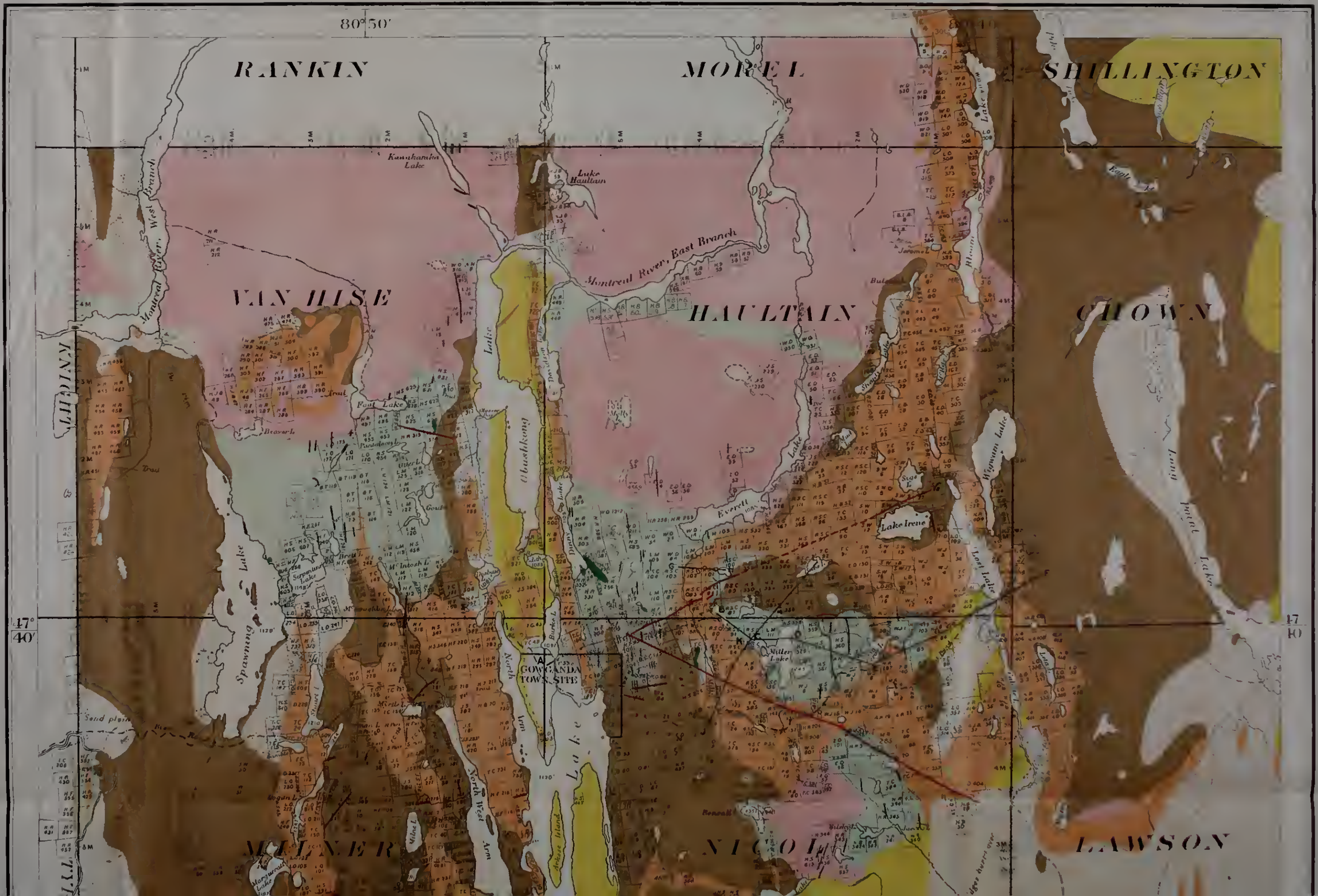
Keewatin
▨ *Quartz-porphyry.*
▨ *Complex of highly altered volcanic rocks, basalt, andesite, &c., tuffs, iron formation.*

/ *Diabase dikes older than Animikean*
🟩 *Serpentine younger than Keewatin.*

Symbols

Road.
Trail.
Transmission line.
P. or Por *Portage.*
F. *Fall.*
R. *Rapid.*
Hill.
Swamp.
1125' *Elevation above sea level.*
o *Shafts.*
Glacial Striae

Magnetic declination N. (8°-9°) W.



Swamp.

1125′ Elevation above sea level.

○ Shafts

Glacial Striae.

Magnetic declination N (8°-9°) W.

SOURCES OF INFORMATION

Geological Map Gowganda Silver Area, Vol. XIX, Part II, Ontario Department of Mines, 1913.

Plans of Surveys from Surveys Branch, Department of Lands and Forests, Ont.

Geological Survey of Canada, Gowganda Mining Division 1909, W. H. Collins.

Special Surveys of Lakes, Roads, Elevations, Etc., by W. R. Rogers.

Additions by A. G. Burrows, 1920.
Compilation of map by P. A. Jackson and H. C. Smith.

Mining Claims

HAULTAIN AND NICOL

R.S.C. 90, 91, 93, 94, 95—Miller Lake-O'Brien.
R.S.C. 83 to 89—Bonsall.
H.S. 351—Symmes-Young.

HAULTAIN

R.S.C. 101, etc.—Castle.
R.S.C. 102—Everett.
S.W. 8—Barbara.
H. S. 350—Miller Lake Syndicate.

NICOL

R.S.C. 106, etc.—Castle.
R.S.C. 98—Walsh.
R.S.C. 135-6—Hart.
T.C. 315—Northern
H.R. 204—Canadian Gowganda.
T.C. 220—Collins.
W.J. 1—Silver Bullion.
W.J. 17—La Fayette.
H.R. 715—Chapelle.
W.D. 961, etc.—Big Four.
W.J. 8, etc.—Leroy.

MOREL

L.O. 305, etc.—Bishop.
E.D. 4. etc.—Donaldson.
W.D. 12A, etc.—Boland.

MILNER

H.R. 249-252—Munn
S.W. 3-5—Reeve-Dobie.
H.F. 221-4—Crews-McFarlan.
H.F. 225—O'Brien.
P.B. 154-5—Welsh.
H.S. 723-4—South Bay.
H.S. 343—Labrick.
T.C. 118—Milne.
H.S. 339—Crawford.
T.C. 136, etc.—Bishop.
H.R. 292, etc.—Gowganda Lake.
J.S. 282—Northcliff.
H.S. 335—Silvers.
H.S. 371—Boyd-Gordon.

LAWSON

H. R. 408—Sanderson
L.O. 357—Caleta.
L.O. 313—Bishop.
H.R. 397, etc.—Powerful.

VAN HISE

H.R. 458—Alpine.
T.C. 141—Hedlund.

DONOVAN

H.R. 720—Duggan.
G.G. 3542—Wilder.

CHARTERS

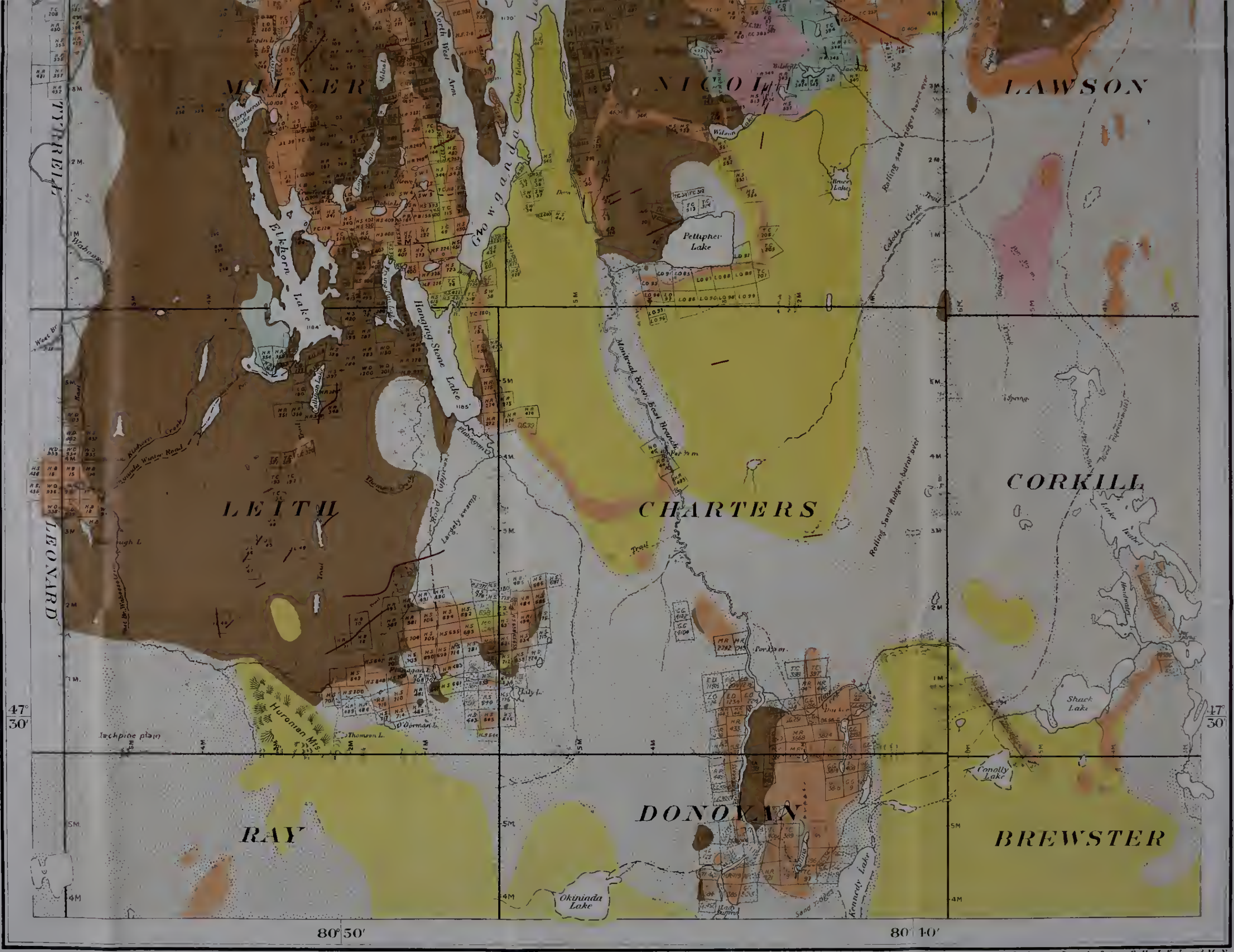
E.D. 123½—Garvey.
H.R. 439-Haines.
G.G. 17, etc.—Willans.

CORKILL

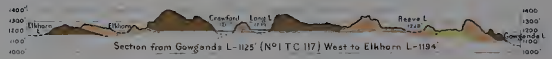
G.G. 3786—Kell

LEITH

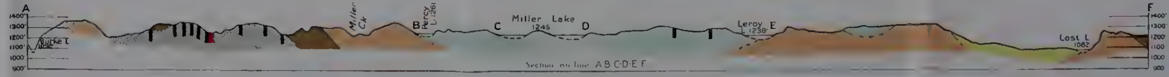
H.S. 716, etc.—Hudson Bay
H.S. 693, etc.—Silverado



See Insert in Report for Sections G.-H., J.-K.-L., and M.-N.

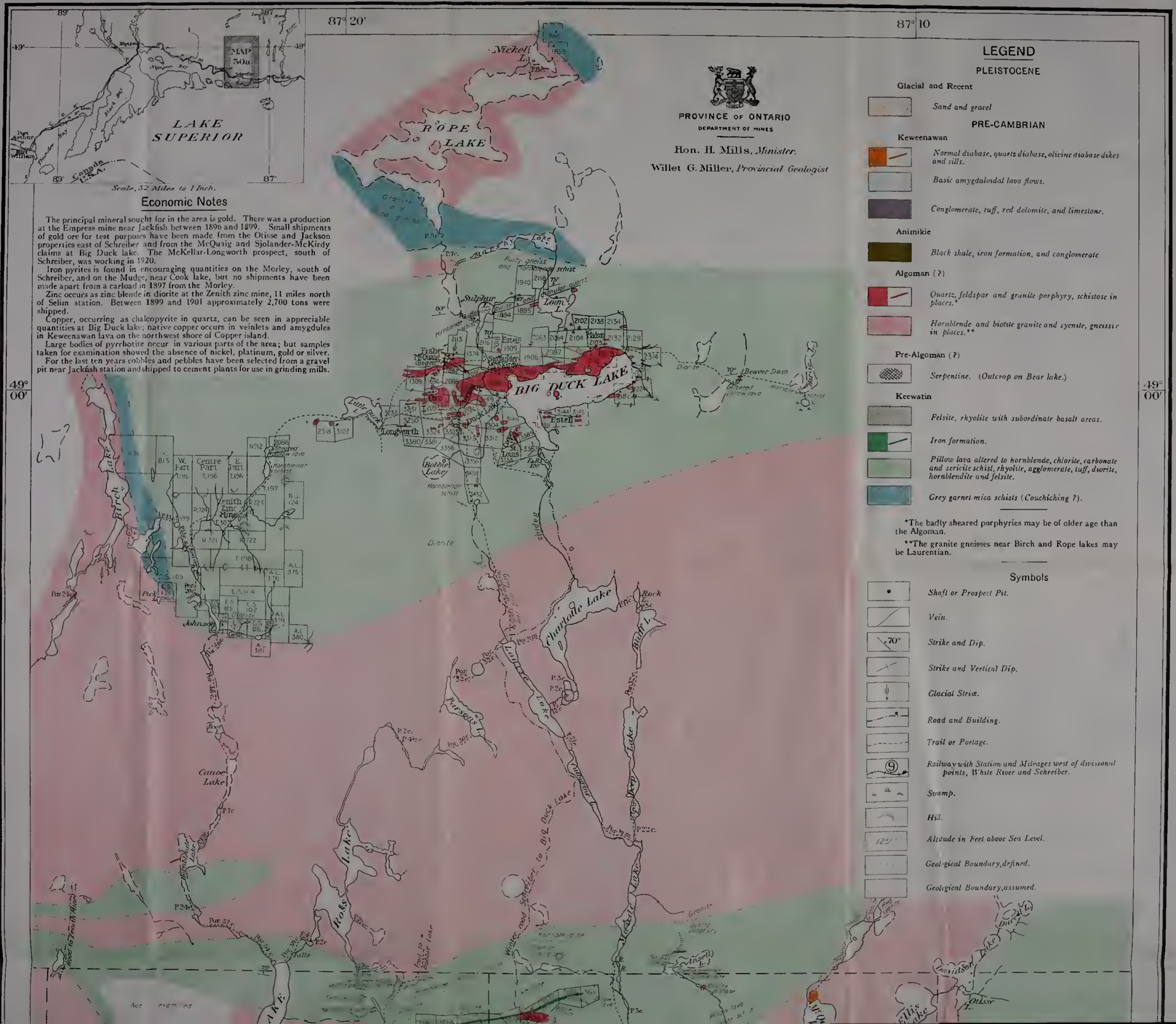


Section from Gowganda L-1125′ (N° I TC 117) West to Elkhorn L-1194′



Section on line A B C D E F

Scale Horizontal ½ Mile - 1 Inch Vertical 800 ft. 1 Inch



PROVINCE OF ONTARIO

DEPARTMENT OF MINES

Hon. H. Mills, *Minister.*
Willet G. Miller, *Provincial Geologist*

Economic Notes

The principal mineral sought for in the area is gold. There was a production at the Empress mine near Jackfish between 1896 and 1899. Small shipments of gold ore for test purposes have been made from the Otisse and Jackson properties east of Schreiber and from the McQuaig and Sjolander-McKirdy claims at Big Duck lake. The McKellar-Longworth prospect, south of Schreiber, was working in 1920.

Iron pyrites is found in encouraging quantities on the Morley, south of Schreiber, and on the Mudge, near Cook lake, but no shipments have been made apart from a carload in 1897 from the Morley.

Zinc occurs as zinc blende in diorite at the Zenith zinc mine, 11 miles north of Selim station. Between 1899 and 1901 approximately 2,700 tons were shipped.

Copper, occurring as chalcopyrite in quartz, can be seen in appreciable quantities at Big Duck lake; native copper occurs in veinlets and amygdules in Keweenawan lava on the northwest shore of Copper island.

Large bodies of pyrrhotite occur in various parts of the area; but samples taken for examination showed the absence of nickel, platinum, gold or silver.

For the last ten years cobbles and pebbles have been selected from a gravel pit near Jackfish station and shipped to cement plants for use in grinding mills.

LEGEND

PLEISTOCENE

Glacial and Recent

Sand and gravel

PRE-CAMBRIAN

Keweenawan

Normal diabase, quartz diabase, olivine diabase dikes and sills.

Basic amygdaloidal lava flows.

Conglomerate, tuff, red dolomite, and limestone.

Animikie

Black shale, iron formation, and conglomerate.

Algoman (?)

*Quartz, feldspar and granite-porphyry, schistose in places.**

*Hornblende and biotite granite and syenite, gneissic in places.***

Pre-Algoman (?)

Serpentine. (Outcrop on Bear lake.)

Keewatin

Felsite, rhyolite with subordinate basalt areas.

Iron formation.

Pillow lava altered to hornblende, chlorite, carbonate and sericite schist, rhyolite, agglomerate, tuff, diorite, hornblendite and felsite.

Grey garnet mica schists (Couchiching ?).

*The badly sheared porphyries may be of older age than the Algoman.

**The granite gneisses near Birch and Rope lakes may be Laurentian.

Symbols

Shaft or Prospect Pit.

Vein.

Strike and Dip.

Strike and Vertical Dip.

Glacial Striæ.

Road and Building.

Trail or Portage.

Railway with Station and Mileages west of divisional points, White River and Schreiber.

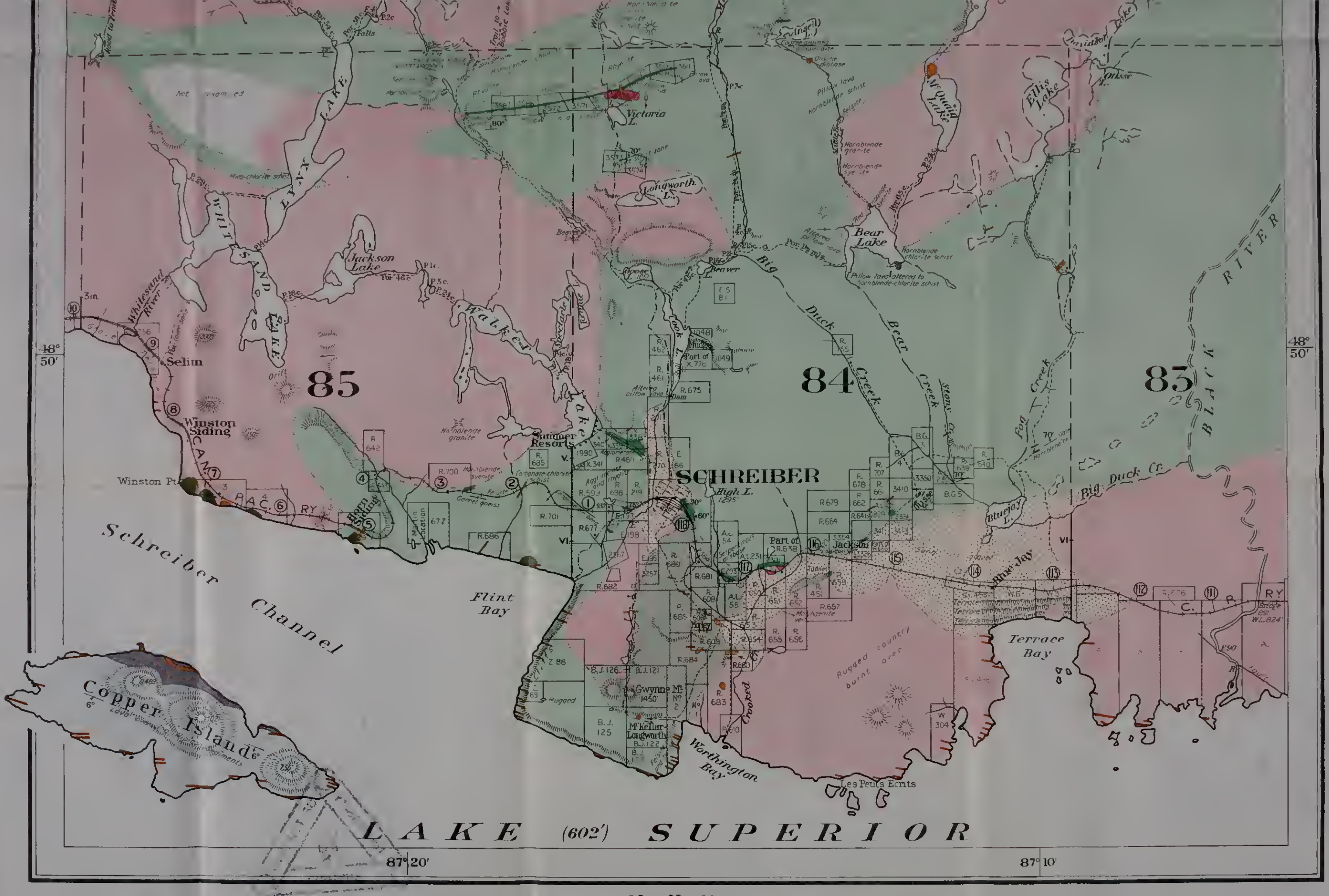
Swamp.

Hill.

Altitude in Feet above Sea Level.

Geological Boundary, defined.

Geological Boundary, assumed.



Map No. 30a.

SCHREIBER-DUCK LAKE AREA

DISTRICT OF THUNDER BAY

To accompany report by P. E. Hopkins, *in Volume 30, Ontario Department of Mines Report, 1921*

Scale : $\frac{1}{63,360}$ or 1 Mile = 1 Inch

Chains 80 40 0 1 2 3 4 Miles

Gold Claims

T.B. 1686—Beaver or McQuaig.
T.B. 1801, 1955—Sjolander-McKirdy.
B.J. 122 McKellar-Longworth.
T.B. 3354, 3326—Jackson.
T.B. 3412 (A.L. 217)—Olisse.

Pyrite Claims

R. 606—Morley.
T.B. 1048—Mudge.

Zinc Claims

30 T—Zenith.
E.S. 79—Gesic.

NOTE—*All claim numbers having four digits are T.B. (Thunder Bay) claims, the letters "T B" having been omitted on the map.*

Sources of Information

Plans from Surveys Branch, Department of Lands and Forests, Ontario.

Lakes shown in solid lines were surveyed by micrometer and prismatic compass.

Magnetic and astronomic north are approximately identical.

Topography and geology of area from Lynx to Birch Lake, Copper island and Rope Lake by T. L. Tanton, Geological Survey of Canada.

Chart from Department of Naval Service of Canada

Geology by P. E. Hopkins.

Drawn by P. A. Jackson and H. C. Smith.

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Geologically Coloured Maps

Part III

No. 30*b*.—Gowganda Silver Area, scale 1 mile to the inch.

Part IV

No. 30*a*.—Schreiber—Duck Lake Area, scale 2 miles to the inch.

Part VI

No. 30*c*.—Black River Area, scale 1 mile to the inch.
No. 30*d*.—Boston-Skead Gold Area, scale ¾ mile to the inch.